POWER

Volume 62 New York, July 21, 1925 *No.* 3

Hot Enough for You?

DO YOU ever walk across one of those gratings in the sidewalk or past one of those basement windows and feel the blast of hot, ill-smelling, grease-laden air blowing from it?

There are men working down there in that atmosphere.

You swelter and stew because it is ninety in the shade. It is hotter than that down there all the time.

Why do men have to work in such places? To keep their jobs and support their families.

Is it necessary that the power plant of an office building, department store or hotel should be such a hell-hole?

Neither necessary, economical nor desirable from other points of view than the comfort of the crew.

Would it cost much to keep it comfortable

On the contrary it costs to keep it uncomfortable.

They are burning coal down there to make steam and steam to run engines.

Every heat unit that gets up that grating instead of into the boiler is a loss.

Every pound of steam that is condensed in those pipes instead of getting to the engine gives up its energy to heating the atmosphere instead of running the works.

Every sweltering man on the job is doing, can only do, a less efficient day's work than he would if he did not have to spend half his time trying to get tolerably comfortable.

The whole lower part of the building is affected by the emanations of the place, and the manager spends as much time there as he would in a hospital for contagious diseases.

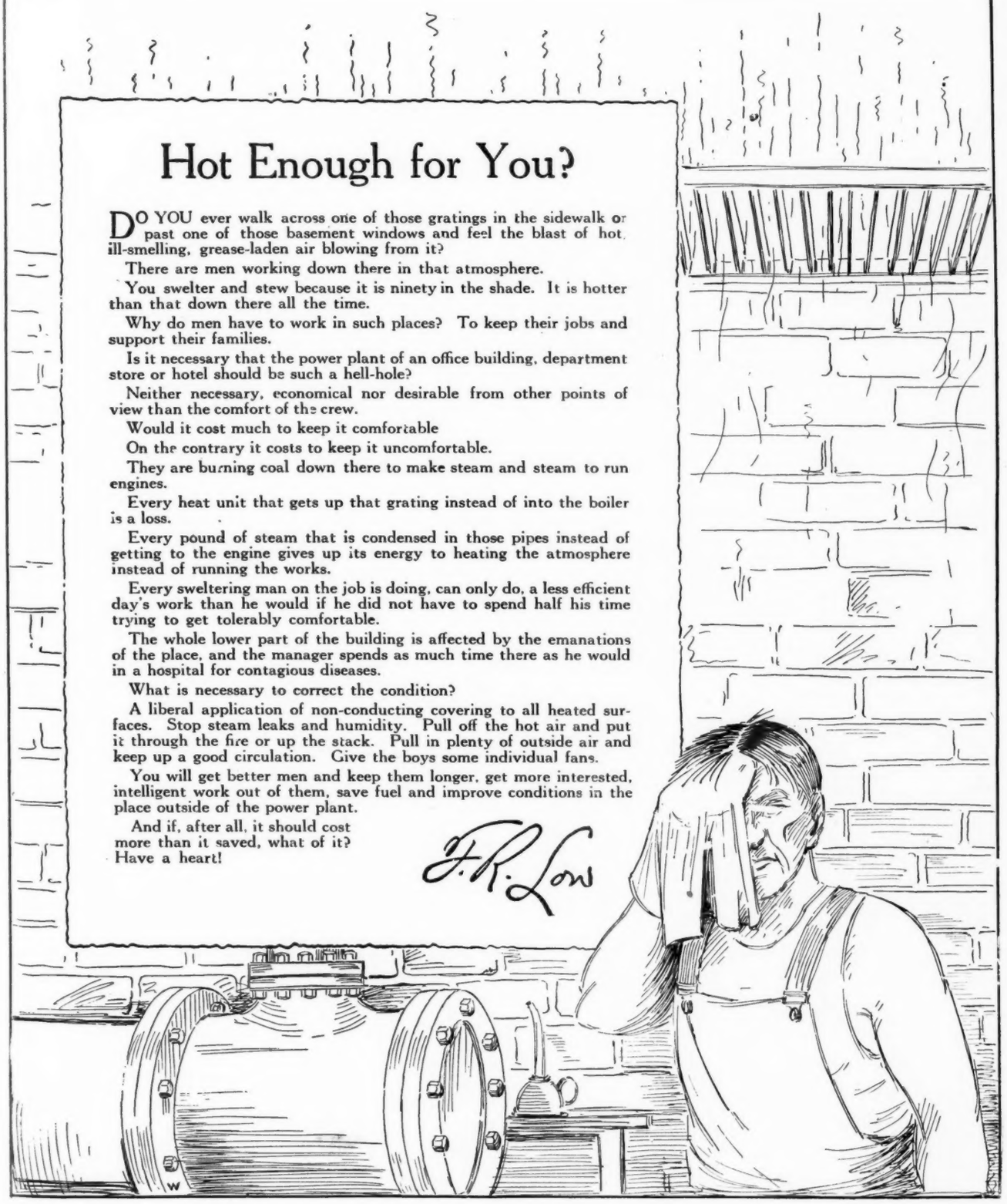
What is necessary to correct the condition?

A liberal application of non-conducting covering to all heated surfaces. Stop steam leaks and humidity. Pull off the hot air and put it through the fire or up the stack. Pull in plenty of outside air and keep up a good circulation. Give the boys some individual fans.

You will get better men and keep them longer, get more interested, intelligent work out of them, save fuel and improve conditions in the place outside of the power plant.

And if, after all, it should cost more than it saved, what of it? Have a heart!

J. R. Low



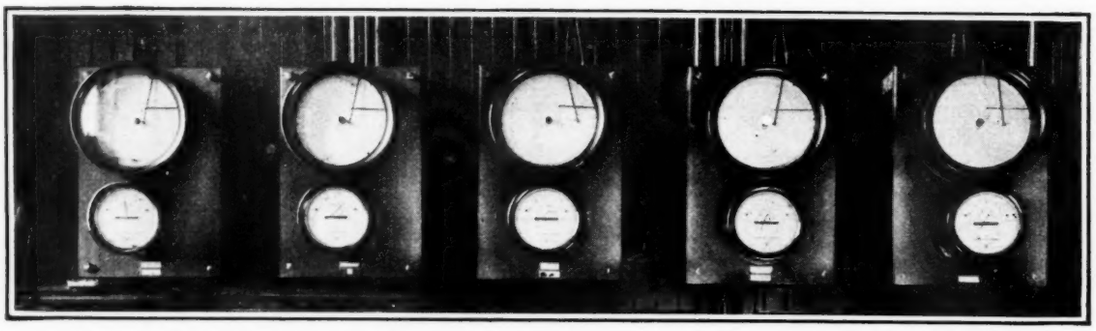


Fig. 1—Five recording flow meters in main office measure live steam supplied to tenants

A Post-Volstead Evolution

The United Refrigeration & Terminals Company is transforming a huge brewery property into a beehive of industries. Ice manufacture, cold storage and freezing of food products, cold storage for furs, garages for electric and gas trucks, laundries and milk pasteurizing plants are already included among the consumers of refrigeration, steam, power, hot water, and well water. Steady improvement in boiler-room operation marks the present stage of development.

CHICAGO, whose stockyards salvage all the hog "except the squeal," must look to her laurels. An evolution now in progress promises a similarly complete utilization of a brewery in New York City. The brewery in question, which did a huge business before prohibition, was that of the Bernheimer & Schwartz Pilsener Brewing Company.

The real start of this story may be dated back to July 13, 1923, when the following news item appeared in the *New York Times*:

A flood of pre-war beer was let loose into Harlem sewers when Federal prohibition officers began the destruction of 836,000 gallons of non-dealcoholized lager and 4,000 barrels of twelve-year-old ale at the plant of the Bernheimer & Schwartz Pilsener Brewing Co., 128th Street and Amsterdam Avenue.

The spilling of the beer, a task which will take several days, is the final step in the passing of one of the city's largest breweries. It was preceded, it was learned yesterday, by the sale of the company's plant to a refrigerating company, at a figure reported to be between $4,000,000 and $5,000,000. The realty deal involved sixty-four city lots and more than twenty buildings, most of them fireproof, the largest plottage, it was said, of any sale in Manhattan for many years.

The Federal agents estimated that the beer was worth $400,000 at pre-Volstead prices and that at bootleg prices it would bring more than $1,000,000.

The Bernheimer & Schwartz Co. has been in business for more than twenty years. Its plant is between 128th and Lawrence Streets on Amsterdam Avenue. It will be operated by the United Refrigeration & Terminals Company, Inc.

The mechanical equipment of this huge property included seven 3,380-sq.ft. water-tube boilers, four engine-driven generators with a combined capacity of 550 kw. and five steam-driven ammonia compressors totaling 1,335 tons of refrigerating capacity. With these went the necessary cooling towers, ammonia condensers, etc. In addition there was a 250-ton distilled-water ice plant with ice storage, cold-storage rooms for beer and ale, and a garage with charging facilities for electric trucks. Besides these there was a quantity of brewing equipment and space devoted to purposes pertinent only to the brewing industry. The original layout is outlined in Fig. 10, no attempt being made to delineate the uses of the various floors.

The fact that steam, electricity and refrigeration can be used for other purposes than brewing led to the purchase of the entire plant by the United Refrigeration & Terminals Co., Inc., with the idea of building up a composite business designed to make the greatest use of all the facilities available.

Much of the mechanical equipment was old and in need of repair, but money was not available to make sweeping changes at once, so a gradual evolution was started, involving the simultaneous building up of a demand for service with a plant capable of rendering that service at a minimum cost. No pretense is made that this plant is today a model in any respect, yet it is of greater practical interest than most model plants because it exemplifies an industrial revolution in full swing which has already transformed a "red-ink" property into a consistent money maker.

The first problem was to secure a definite income. This has been successfully accomplished by the commercial operation of the ice plant, garages and a public cold-storage plant for perishable merchandise, and by securing as tenants for otherwise unoccupied buildings laundries, electric garages, milk companies, fur-storage companies and other concerns having particular need for refrigeration, steam, hot water or electricity.

That this stage of the development is well advanced, is evident from a study of Fig. 11 showing the principal uses of the various buildings on July 1, 1925. With little change in external appearance the actual transformation has been remarkable. The tenants on that date and the principal services supplied are listed in Table I.

Some equitable method of charging for the service supplied being a pressing necessity, five flow meters were installed in the main office of the plant to measure live steam supplied to tenants. Individual meters for

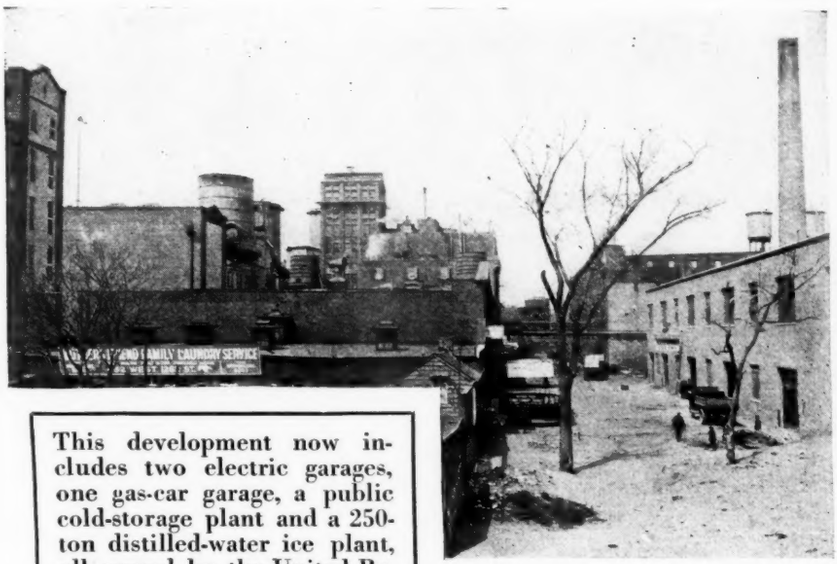
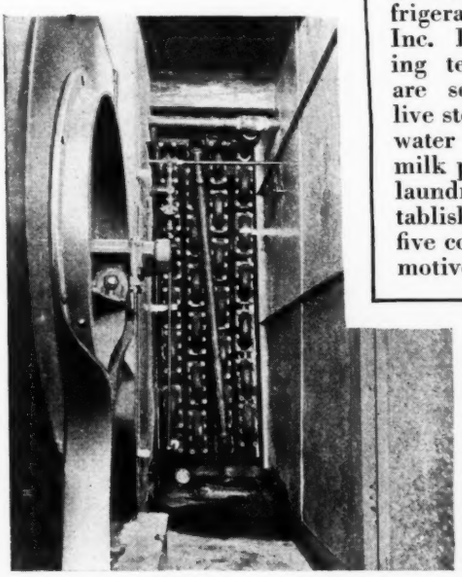


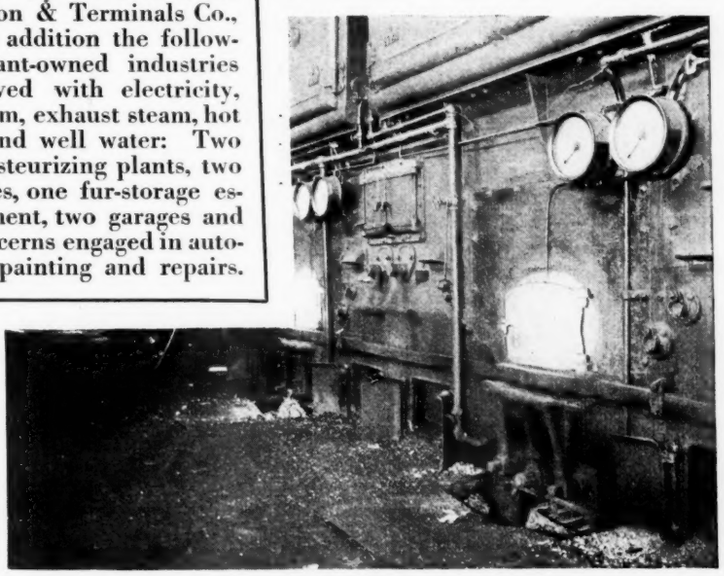
Fig. 2 (Right) — General View of Development

Starting at the boiler room, marked by the stack, service in the form of electricity, live steam, exhaust steam or refrigeration extends to practically every point in this picture, which was taken from Convent Avenue looking down 128th Street toward Amsterdam Avenue. Note laundries, garages, milk station, cooling towers, etc.

This development now includes two electric garages, one gas-car garage, a public cold-storage plant and a 250-ton distilled-water ice plant, all owned by the United Refrigeration & Terminals Co., Inc. In addition the following tenant-owned industries are served with electricity, live steam, exhaust steam, hot water and well water: Two milk pasteurizing plants, two laundries, one fur-storage establishment, two garages and five concerns engaged in automotive painting and repairs.

Fig. 3 (Below) — Air, cooled by blowing over these ammonia coils, is sold for fur storage





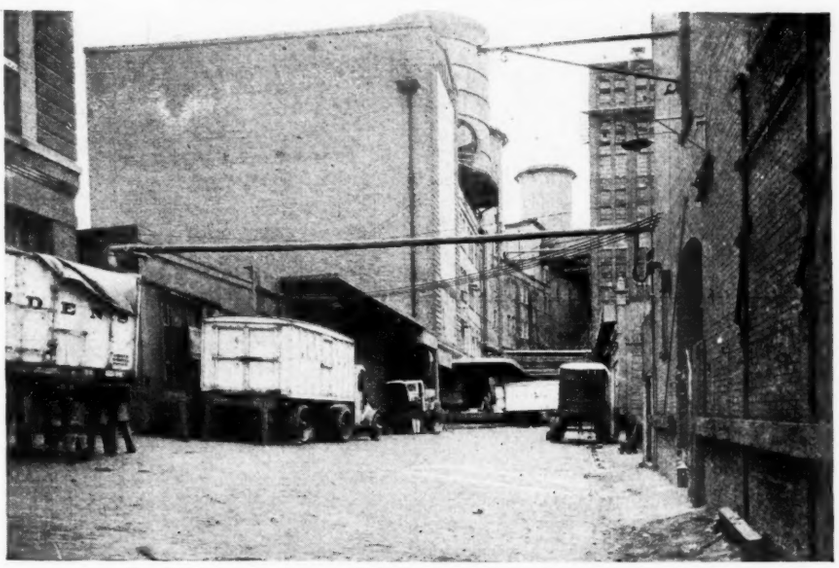


Fig. 4 (Above) — Draft gage and steam-flow meter mounted on front of each boiler

Firemen are instructed to operate fires so as to maintain same readings (arbitrary scales) on both dials.

Fig. 5 (Left)—View looking west on court between buildings facing 127th St. and 128th St., showing cooling towers and milk trucks

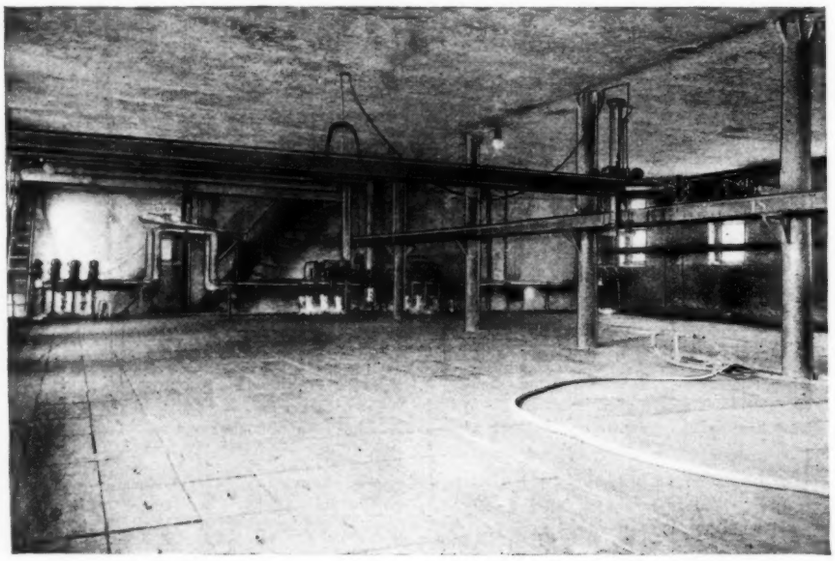
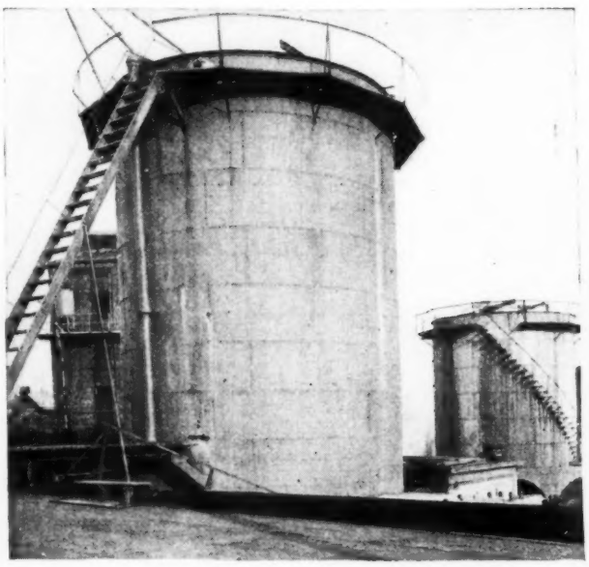


Fig. 6 (Left)—The U. R. & T. Co. operates this 250-ton distilled-water ice plant

Fig. 8 (Below) — Gage-board in fireroom holds electric CO_2 recorder and recorders for steam flow, feed temperature, flue temperature, steam temperature and steam presssure



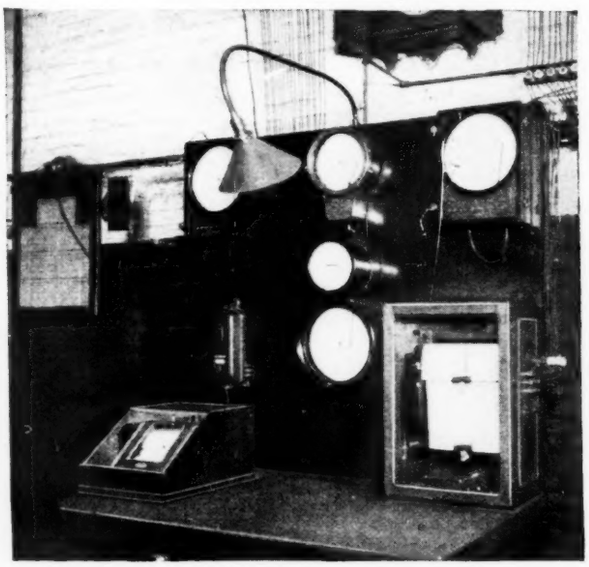


Fig. 7 (Above)—In foreground are two 1,200-gal.-per-min. cooling towers for ammonia condensers. In background is 3,500-gal.-per-min. cooling tower for steam-condenser circulating water

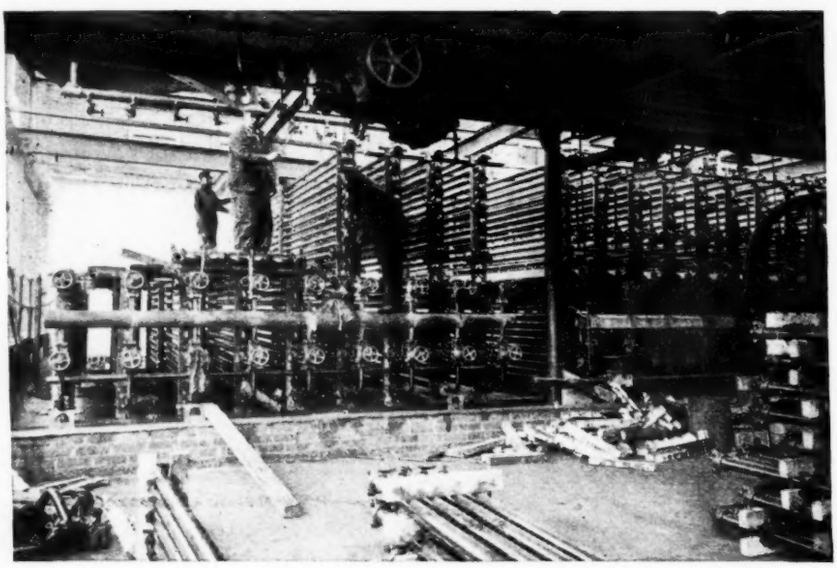


Fig. 9 (Right)—Renewing old ammonia condenser. Total ammonia condensing surface in plant is 15,168 sq.ft.

hot-water and well-water consumption have been installed on the tenants' premises, while the electricity used by tenants is measured by watt-hour meters in the engine rooms. Additional watt-hour meters were placed in the electric garages. Four hot-water regulators were installed to control the temperature of the hot water delivered to tenants.

A complete list of new instruments is given in Table II. The old plant was practically without instruments.

It will be noted that Table II contains, in addition to the already mentioned meters pertaining to customer service, a considerable number of boiler-room instruments.

The revamping of the boiler room, now in full swing, indication on both instruments gives the most economical air-coal ratio for all loads.

With the aid of these methods and instruments there has been a marked improvement in boiler-room efficiency; namely, 19 per cent increased evaporation per pound of coal with an actual reduction of power-operating expense during the second quarter of 1925 by 19.1 per cent as compared with the first quarter. Further gains are expected when the revamping of the boilers and settings, now in progress, is complete.

Having made the first attack at the point of greatest loss, this process of gradual improvement will later be extended to the engine room, refrigeration plants, etc. The problem of more extensive use of exhaust steam is also under consideration. At present some of the

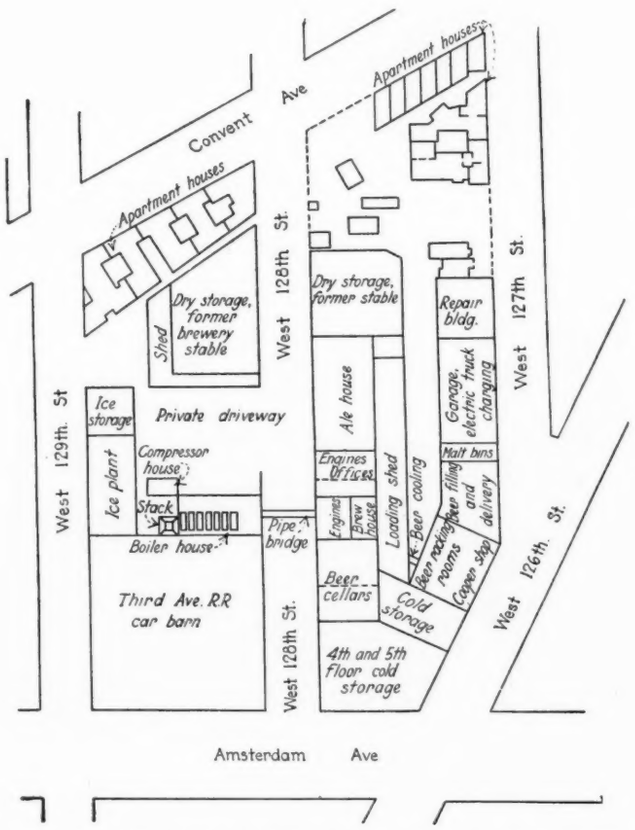


Fig. 10—Layout of original plant for brewing purposes

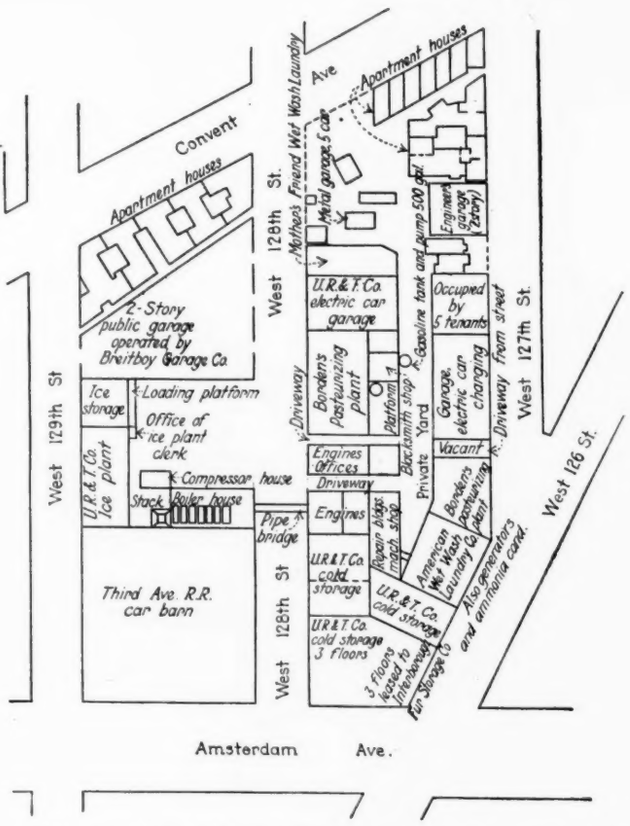


Fig. 11—Plant transformed for industrial purposes

was properly the second step in this evolution after attention had been given to the needs of the tenants.

The boiler room was in bad shape, so that large savings were possible at this point. The first step was to install instruments necessary to check efficiency, control operation intelligently and forestall losses. Some of these are shown in Figs. 4 and 8. The fireroom gage board (Fig. 8) contains a recorder giving the flue-gas temperature at each boiler, an electric recording meter giving the CO_2 of each boiler, temperature recorders for feed water and steam, and a steam-pressure recorder. These give a good check on daily operation.

As a sensitive guide to furnace control two indicating meters have been placed on the front of each boiler as shown in Fig. 4. One measures the output (steam flow) of the given boiler, while the other indicates the draft drop through the boiler. The scales are arbitrarily graduated so that operation with the same

engines run condensing, incidentally producing distilled water for ice. Of three cooling towers on the roof one is used for the cooling of steam condenser circulating water and the other two for ammonia condensing water. Much exhaust steam is used directly by tenants for heating and in the form of hot water by the laundries and milk plants, but an excess is still available.

One interesting feature of this project is the economy effected by the extensive use of water from shallow wells in place of city water. With a summer temperature of 56 deg. F., this well water is used, among other applications, as a cheap refrigerant for precooling milk in the pasteurizing plants, with a substantial saving in power-generated refrigeration.

It is evident that a layout of this sort presents a remarkable opportunity for the co-operation of engineers and business men in securing an economical balance between the demand and supply of steam, elec-

tricity, refrigeration and hot water. The engineering plans for this development were worked out by Walter N. Polakov, Inc., Consulting Engineers, who now supervise their execution and economic operation.

TABLE I—USERS OF SERVICE

User	Something about size	Service Supplied: Well Water	Steam	Refrigeration	Electricity	Hot Water
Borden's 127th St. Pasteurizing Plant*	3,000 cans daily	x	x	x	x	x
Borden's 128th St. Pasteurizing Plant*	1,500 cans daily	x	x	x	x	x
Mother's Friend Laundry*	30 people		x		x	x
American Wet Wash Laundry*	75 people		x		x	x
Breitboy Garage*	400 cars		Heat		x	
Engineers Garage*	175 cars		Heat		x	
New Electric Garage	25 cars		Heat		x	
Interborough Fur Storage Co.*	350,000 cu.ft.			Cold Air	x	
Michaelis Auto Repair & Paint. Co.*	6,000 sq.ft.		Heat		x	
Forost Motor (repair) Co.*	6,000 sq.ft.		Heat		x	
Bronx Hygrade Auto Painting Co.*	6,000 sq.ft.		Heat		x	
Standard Auto Painting Co.*	6,000 sq.ft.		Heat		x	
Harry Ison (motorcycle) Co.*	6,000 sq.ft.		Heat		x	
Old Electric Garage	25 cars		Heat		x	
Ice Plant	250 tons			x	x	
Gas Car Garage	5 cars		Heat		x	
Public Cold Storage	1,000,000 cu.ft.			x	x	

*Tenant. x indicates service supplied.

TABLE II—NEW INSTRUMENTS INSTALLED

No.	Kind	Make	Measure	Where Located
7	Steam flow	Republic	Individual boiler output	Front of each boiler
7	Draft gage	Republic	Draft through boiler	Front of each boiler
1	Pyrometer	Thwing	Flue-gas temp. of each boiler	Fireroom gage board
7	Electric flue-gas testers	Siemens & Halske (Bacharach)	CO_2 of each boiler	Side of each boiler
1	Recording elec. CO_2 meter	Bacharach	CO_2 of each boiler	Fireroom gage board
1	Feed-water temp. recorder	American Steam Gage & Valve Co.	Temp. water in and out of economizer	Fireroom gage board
1	Steam-press. recorder	Schaeffer & Budenberg	Steam pressure	Fireroom gage board
1	Steam-temp. recorder	American Steam Gage & Valve Co.	Steam temperature	Fireroom gage board
5	Steam flow	Republic	Steam to tenants	Main office
7	Watt-hour	Sangamo	Electricity to tenants	Tenants' premises
1	Watt-hour	Sangamo	Generators' output	
2	Watt-hour	Bristol-Sangamo	Car charging in electric garages	New and old electric garages
10	Water	Worthington	Hot water and well water to tenants	Tenants' premises
4	Temperature regulators	Sarco	Control temp. of hot water to tenant	Hot-water tanks

Material for this article has been gathered with the co-operation of L. M. Beeten, general manager, and B. M. Stuart, chief engineer, of the United Refrigeration & Terminals Co., Inc.

Correcting Low Power Factor

BY CHARLES R. UNDERHILL*

Just as a purchaser of a standard product may know little of its details of manufacture, so may a manufacturing executive as a purchaser of electric power know little about the details that go to make up his power bill. Take the two-charge rate, for instance, where a charge is made for the energy consumed and another for the demand. The latter may be considered as a stand-by charge for having equipment and energy supply ready at all time for the use of the consumer upon demand without notice. Such rates may include a power-factor clause, such as the demand charge is to be multiplied by an amount equal to 70 divided by the measured power factor. In such a case, where the power factor is less than 70 per cent the billing demand will be greater than the measured demand, and when the power factor is higher than 70 per cent the billing demand will be less than the measured demand.

To illustrate, assume that the energy consumption of a given load is 40,000 kw.-hr. with a measured demand of 200 kw. The average power factor of the load is 55 per cent, which is to be applied to the demand as previously explained. This would make the billing demand equal to $200 \times \frac{70}{55} = 254$ kilowatts.

Let the first 10,000 kw.hr. cost 2c. per kw.-hr., or	$200.00
The remaining 30,000 kw.-hr. costs 1.25c. per kw.-hr., or	$375.00
Then the total energy charge is	$575.00
Let the first 50 kw. of demand be billed at $2.50 per kw., or costs	$125.00
The remaining 204 kw. demand is billed at $1.60 per kw., or costs	$326.40
	$451.40

Then, the total amount of the bill will be 575 + 451.40 = $1,026.40, which is the sum of the energy and demand charge.

If the measured power factor had been 70 per cent instead of 55, the billing demand would have been $200 \times \frac{70}{70} = 200$ kilowatts, the same as the measured demand. Then the demand charge would have been $(50 \times 2.50) + (150 \times 1.60) = \$365$ instead of $451.40, or $86.40 less. This saving in the demand charge is equal to $(86.40 \div 451.40) \times 100 = 19.14$ per cent under that at 55 per cent power factor. Another way of putting this is, the amount that the customer must pay for the demand charge is $(86.40 \div 365) \times 100 = 24$ per cent higher at 55 per cent power factor than at 70 per cent.

It is easily understood why a charge should be made for energy delivered and also for the demand, stand-by or insurance, according to the point of view regarding the demand, but the power-factor penalty is not so readily understood as a rule. In fact, the writer has often been asked, "What is the power factor, and why should it affect the demand?" Power factor affects the demand because when it is less than unity more current is required in the lines and equipment for the same amount of power than at unity. Therefore, generating, distribution and transmitting equipment of greater current-carrying capacity must be provided, which results in a greater initial cost for a given kilowatt capacity.

It is seldom practicable to make the power factor greater than 90 per cent, owing to the cost of equipment necessary to increase it above this percentage. The power factor is a ratio, generally defined as the ratio of the measured power in kilowatts to the kilovolt-amperes. The plant power factor may be increased by connecting either a static or a synchronous condenser across the plant terminals, but this method does not reduce the losses in the distribution system. These losses may be decreased by increasing the power factor of each motor by connecting either a static condenser across the motor's terminals, or by replacing induction motors with synchronous or synchronous-induction motors. Another method of correcting power factor is to connect static or synchronous condensers at centers of distribution.

Generally, the simplest method of correcting power factor is to load the induction motors properly by changing them around in the plant so that each motor will be on the right job to keep it as nearly loaded as practicable.

*Consulting Engineer, Waterbury, Conn.

Avoiding Compressor Explosions

By Thomas O. Organ

EXPLOSIONS in compressor cylinders, receivers and air pipes have long been the subject of discussion among engineers and operators of compressed-air plants. Occasionally, one hears of a case of fire or explosion which to some appears to be a seriouus objection to the use of air, but if the cause is known and understood and due care is observed, such trouble will not occur.

Effect of Too Much Oil

In a great many instances ignition may be traced to poor oil, and in some instances the cause can be attributed to too much oil. It is a mistake for an engineer to use too much oil in an air-compressor cylinder, for the reason that it is only necessary to maintain a thin film on the cylinder walls, as there is no tendency in an air-compressor cylinder to wash the oil from the walls of the cylinder. If too much oil is used, carbon will gradually accumulate, interfering with the movement of the valves; it will also choke up the discharge passages which may cause a high temperature followed by ignition. It is best to procure the highest-grade lubricant and to use little of it.

Sometimes firing is caused by the introduction of kerosene in the air cylinder for the purpose of removing carbon and cleaning the valves. The inflammability of such material as kerosene, naphtha and benzine is so acute it is a dangerous experiment to introduce it into any kind of a cylinder. To clean an air-compressor cylinder and valves, it is best to use soft soap and water, feeding the mixture into the cylinder through the regular lubricator. It is not an uncommon thing for ignition to occur in compressed-air discharge pipes, and there are instances on record where the air-compressor pipes became red hot.

Use Thin Oil with High Flash Point

Ignition has been known to extend into the air receiver, and there is one instance where the flame was carried down into a mine by the compressed air. It is plain that there cannot be ignition or explosion without an increase of temperature to above the flash point of the oil. Thick or cheap grades of cylinder oil should never be used in an air compressor. Thin oil, which has a high flash point and is as free from carbon as conditions will admit, is the best oil for air compressors.

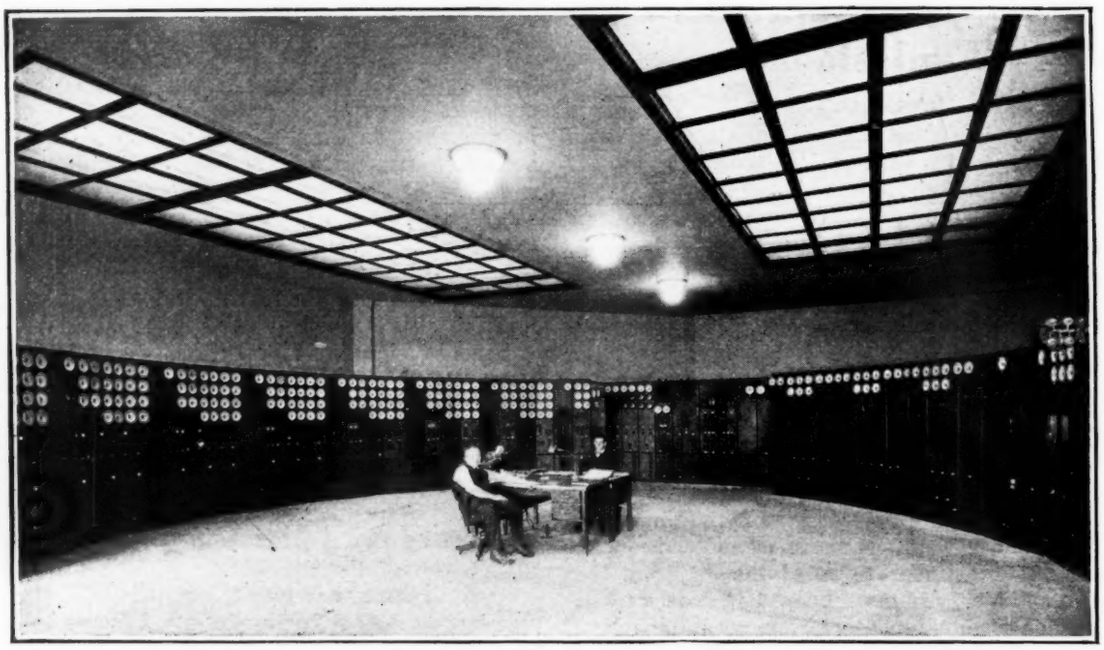
Explosions have occurred where oil has been used with a flash point of 554 deg. F. and an ignition point at 606 deg. F. Ignition has also occurred with an oil of a flash point of 575 deg. F. and a fire point of 625 deg. F. The conditions under which the air compressors were operated were about 60 lb. per sq.in. Should the temperature of the air before admission to the air compressor be 60 deg. F. and if the air be compressed to 60 lb. gage, the final temperature without cooling will be 369 deg. F., or an increase of 309 deg. If air is admitted at 60 deg. F. and compressed without cooling to 74 lb. pressure, the final temperature would be 414 deg. F. This would mean a total increase in the temperature of 354. The question often asked is, Why it is possible when using oil with a fire point of 600 deg., for ignition to occur, especially if the cylinders are water jacketed? The increase of temperature may be caused by an increase of pressure which is not recorded on the gage, or it may be an increase of temperature without a corresponding increase of pressure. For instance, carbon from oil may be deposited on the piston head, cylinder head, valves and discharge pipes. The area of the discharge pipes when coated with carbon deposit obstructs the passages, therefore the air does not flow away freely from the compressor. This momentary increase of pressure would surely carry with it an increase of temperature, which might exceed the ignition point of the oil. Ignition has occurred in well-designed compressors and systems of piping, therefore it is necessary to look for other causes. Not only has ignition occurred where hot air has been drawn into the cylinder, but also when the incoming air has been normal and the discharge pipes were free and of ample area.

The only possible explanation that can be given is that the temperature of the incoming air is made excessive by the sticking of one or more of the discharge valves, thereby letting some of the hot compressed air leak back into the cylinder to influence the temperature before compression. After the piston has compressed the air and is reversed, a leaking valve will cause a portion of the air to rush back into the cylinder to be recompressed, and at the end of the suction stroke the cylinder is full of hot air to be recompressed.

Suppose air is being compressed to 74 lb. gage pressure and through leaking valves the cylinder should be filled with air at a temperature of 300 deg. before compression, the result will be a final temperature of 833 deg. F., far above the ignition point of the oil lubricating. Pockets such as are formed in tees, elbows, etc., should be eliminated as much as possible, as these pockets become receptacles for oil which add fuel for the fire if ignition should occur.

Examine the discharge valves and see that they seat themselves perfectly at all times, so that there will be no return of the air to the cylinder to be recompressed. Use the oil sparingly in the cylinder, as very little lubricant is required. Have as few bends and tees in the pipes as possible. Draw the air from the coolest part of the room or the outside temperature, and see that it is not loaded with dust. Use soft soap and water for the cleansing of air valves and air passages.

If a piston ring of an oil engine sticks in the groove, the gum can be loosened by using a piece of spring brass. Copious supplies of kerosene will also serve to loosen the ring; lye water is equally serviceable. The groove and ring should be thoroughly cleaned before the ring is placed on the piston. If the ring is new, frequently the edges are rough and sharp; all roughness should be removed by a smooth file. In replacing piston rings, the ring should be fitted to the cylinder with about 0.01-in. gap clearance between the parted ends. The outside surface of the ring should be coated with lampblack, and then the ring is slipped into the cylinder. The contact between the cylinder and ring will remove the lampblack at all points of contact. By smooth filing the ring can be fitted to the cylinder. Proper fitting is necessary to prevent the escape of the gases across a point of non-contact.



Switchboard from which nearly one-half million horsepower is controlled

Three 65,000-Kva. Generators at Niagara Falls

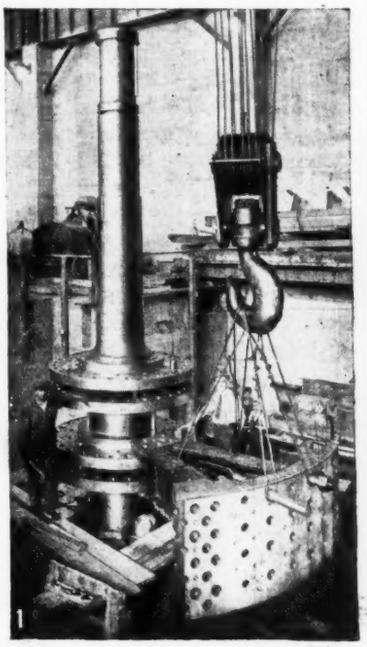
Largest Hydro-Electric Generators Ever Constructed—Efficiency over 98 per Cent—Special Provision in Generators for Protection Against Fire—Transformers' Efficiency Over 99 per Cent

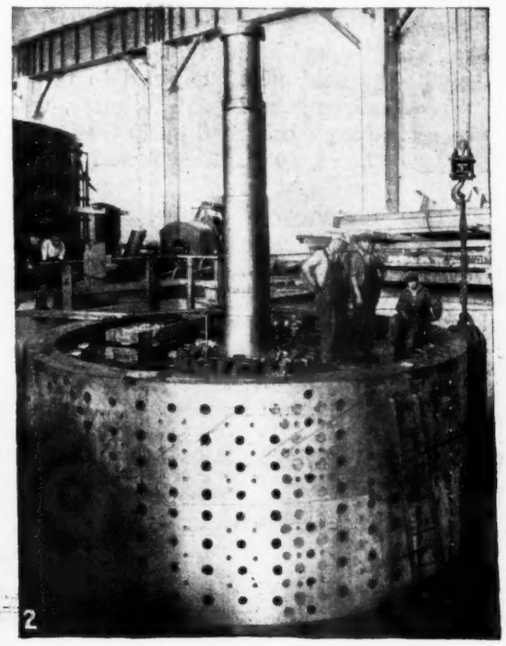
ALMOST thirty years ago the first 3,750-kw. generator was put into commercial operation in what is now known as power house No. 1 of The Niagara Falls Power Co. This machine represented an increase in capacity of about ten times over any single alternating-current generator previously constructed and also marked the commercial beginning to develop power at Niagara Falls on a large scale. Since that time a number of records for size of hydro-electric units have been established at Niagara Falls. The most recent was last year, when the previously mentioned company put into commercial operation three 65,000-kva. units, each having a capacity equal to over 16 times that of the first record machine. Although these machines are of record size, each weighing approximately 1,500,000 lb., the most noteworthy feature about them is their high efficiency.

A comparison of some of the outstanding features of the earlier type of units and the latest will be of interest in showing advances in the art. The old-type machines had an efficiency of about 92 per cent compared with over 98 for the new units. The original machines had a stationary field structure about which the armature revolved like a large umbrella, supported from the upper end of the turbine shaft, whereas the new machines are of the conventional type with the field structure revolving inside the stator. The old machines were designed for two-phase 2,200 volts at unity power factor, and the new units are for three-phase 12,000 volts and 80 per cent power factor and are capable of carrying their full rated load at 13,200 volts. A Kingsbury thrust bearing designed for a 1,250,000-lb. load and located on top of the new units, supports the rotating element, where in the old an oil-pressure step bearing located beneath the generators was used. The new generators are so close to their turbines that they have no lower steady bearing. There are two steady bearings in each unit, one in the upper supporting structure over the generator and one on the turbine. On the old machine the generator is about 140 ft. above the turbine and has several steady bearings on the shaft.

A feature that shows the advances in design better probably than any other is the weight of material per kilovolt-ampere output, which in the new machines is less than half that in the old machines, being 19.4 and 23 lb. in the former and nearly 50 in the latter. The new machines are exceptionally large for their speed on account of being designed for the highest commercial economical efficiency.

Two of these generators, Nos. 19 and 20, were built by the General Electric Co., and the two wheels for these machines were supplied by the Wm. Cramp & Sons Ship & Engine Building Co., and one complete unit, No. 21, turbine and generator was built by the Allis-Chalmers Manufacturing Co. In general the outside appearance of all three generators is the same. The most marked difference in their mechanical construction is found in the rotors. In units Nos. 19 and 20, the





Figs. 1 and 2—Construction of rotor spider for unit No. 21

This rotor spider is made of two built-up wheels, each consisting of seven sections having two arms cast integral with the rim. These are bolted to a solid cast-steel hub, and the sections are joined at the rim with forged-steel tongues running the full width of the rim.

Fig. 3—Type of rotor spider used in units Nos. 19 and 20, with two field poles in place

The rotor spider is made of five cast-steel wheels. Each wheel is cast in half and fastened together at the rim with nickel-steel shrink links extending across the full width of the rim. The hubs are rabbetted and held to the shaft with bolts.

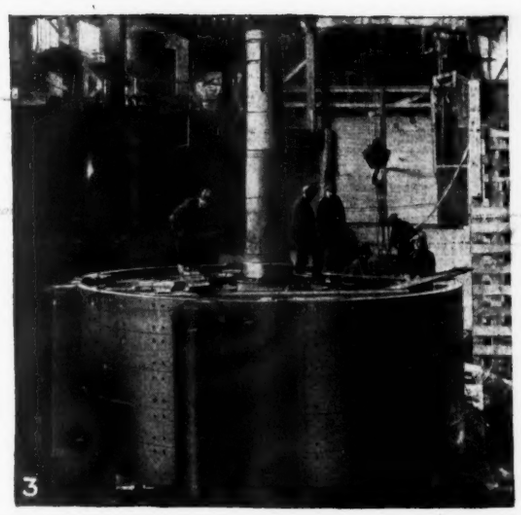
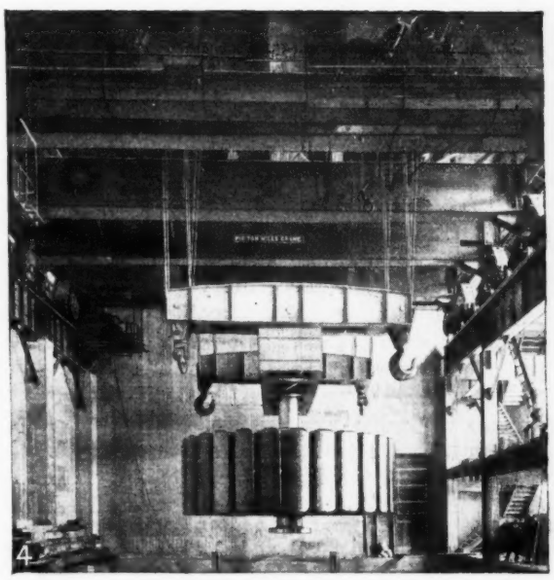


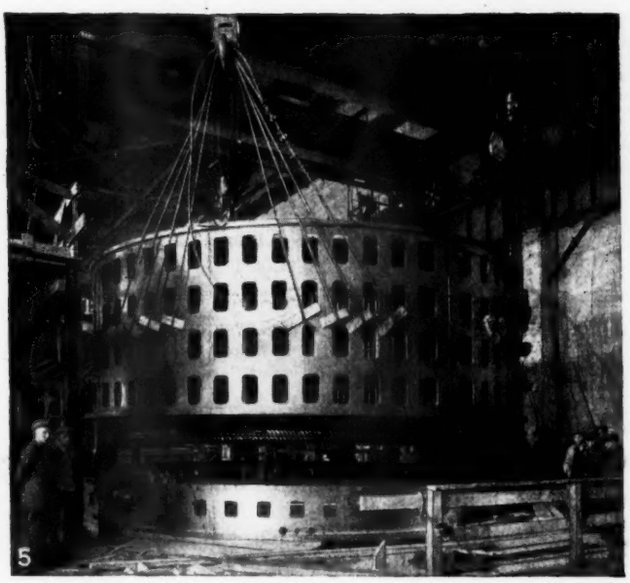
Fig. 4—Method of lifting the generator rotors after assembly in the power house

The rotor for units Nos. 19 and 20 weighs, with the lifting beams, 399 tons. This load was handled with two 200-ton cranes, each equipped with two 100-ton hoists. The total load on the crane rails was about 550 tons.

Fig. 5—The stators were assembled in the power house while the rest of the machine was being installed and then placed on their base by two 200-ton cranes

For units Nos. 19 and 20, the stator completely assembled with its winding weighs 235 tons, and that for unit No. 21 weighs 225 tons.





rotor spider is made of 5 cast-steel wheels, Fig. 3. Each wheel is cast in half and fastened together at the rim with two nickel-steel shrink links extending across the full width of the rim. The hubs are rabbetted and held to the shaft with 12 nickel-steel bolts. The field poles are built up of steel laminations ¼ in. thick and held between heavy cast-steel end plates by through bolts.

On account of the stator frame being so large, 30 ft. 4 in. outside diameter by 10 ft. high, it was cast in four sections, which are doweled and keyed together to stand maximum short-circuit strains. The stator frame was shipped in sections and assembled at the plant, after which the laminated core was built in. The core is held between extra-heavy steel plates by steel bolts running the entire length of the core between the lamination and the frame. In the winding there are 360 coils insulated with mica, each coil weighing 186 lb., giving the complete winding with the end connections a weight of 70,000 lb.

These units have a guaranteed efficiency of 98.1 per cent at 65,000 kva. and unity power factor; 97.8 per cent at 0.90 power factor and 97.5 at 0.80 power factor. Tests show that they come well within their guarantees. The excitation required at full load and 0.80 power factor is about 0.4 of one per cent of the rating of the machine, which is a very low value.

In unit No. 21 the rotor spider is made of two built-up wheels, each consisting of seven sections having two arms cast integral with the rim, Figs. 1 and 2. These are bolted to a solid cast-steel hub by means of reamed bolts passing through the ends of the arms and the two hub flanges. For joining the sections of the rim, forged-steel tongues running the full width of the rim, are used. Large dowels are driven through the tongues and rim.

The main body of the polepieces is made of rolled steel dovetailed to receive the laminated pole face. This is a new departure from the regular construction, where the polepiece is laminated. In building up the pole faces, the laminations were stacked in place and then clamped between heavy steel end plates bolted and doweled to the pole body.

The rotor, which weighs 670,000 lb. and is 22 ft. 8 in. in diameter, was completely assembled in the shop and tested at 100 per cent overspeed. This test was made in a concrete-lined pit especially designed for this purpose. The rotor was driven by a large vertical direct current motor.

As in the machine previously described, the stator core of No. 21 generator was shipped in sections and assembled in the plant. The laminated core is held to the stator frame by dovetails and clamped between heavy cast manganese-bronze end plates. This material was used for the end plates on the core, on account of its great strength and non-magnetic qualities, the latter helping to keep down the stray-power losses. There are 420 coils in the winding, each one having 4 turns built up of 12 strands in multiple, separated by mica insulation to reduce eddy currents in the copper.

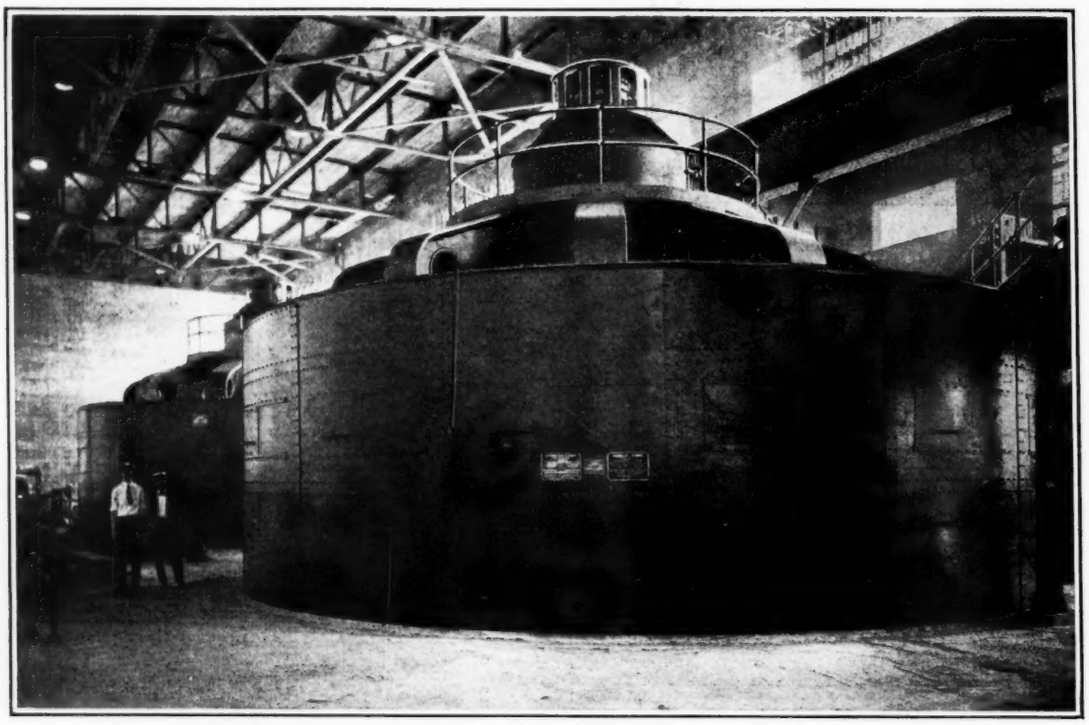


Fig. 6—Two of the three 65,000-kva. generators

Each generator is 30 ft. 4 in. outside diameter and weighs over one and one-half million pounds. The thrust bearing, which is located above the generator, is designed for a load of one and one-quarter million pounds.

Between the top of the main generator and the guide bearing in each machine is mounted a 650-kva. 2,300-volt three-phase 25-cycle auxiliary generator, Fig. 7, to supply power to the auxiliary motors of its particular unit, so that each main machine may be considered an independent power station.

Special provisions have been made in the generators for protecting them against fire. An arrangement of baffles has been placed near the end windings in such a way as to direct the air flow through them radially. In case a fire should start, it will be localized by this radial air flow and not carried around the stator. At suitable locations near the coil projections sprinkler heads connected through a valve to a pressure water system have been installed. Air pressure is maintained on

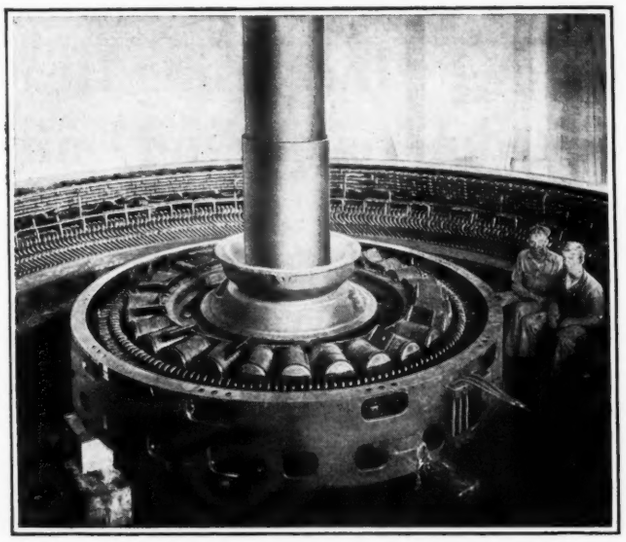


Fig. 7—Auxilary generator, rated at 650-kva. and 2,300 volts, located in the top of the main generators

these sprinkler heads, and should any of them open, the reduction in air pressure causes an alarm to be given, calling the operator's attention to the condition. If a fire exists in the machine, the radially directed air flow gives the operator time to use his judgment as to whether to turn on the water or use other available fire extinguishing means. If the operator finally turns on the water, it is localized to the section in which the fire has started, consequently only a small portion of the winding gets wet.

These two special features, the main-shaft auxiliary generator and the fire protective system, were devised

COMPARISON OF GENERATORS

	Units Nos. 19 and 20	Unit No. 21
Rating, kva.	65,000	65,000
Volts	12,000	12,000
Cycles	25	25
Phases	3	3
Height from floor to highest point	26 ft. 3 in.	26 ft. 3 in.
Outside diameter	30 ft. 4 in.	29 ft. 8 in.
Weight of stator, lb.	470,000	449,300
Weight of complete rotor with shaft, lb.	783,000	670,000
Thrust bearing designed for load of, lb.	1,250,000	1,250,000
Total weight of unit, lb.	1,538,000	1,300,900
Net weight per kva. output, lb.	23	19.4
Flywheel effect, WR^2	65,000,000	49,500,000
Size of copper in field coils	0.43x2.625 in.	0.4x3 in.
Weight of copper in each coil, lb.	2,800	2,750
Number of stator coils	360	420
Coil pitch, per cent	70	80
Kind of insulation	Mica	Mica
Weight of one insulated coil, lb.	186	141
Total weight of stator winding, lb.	70,000	62,000
Number of turns per coil	3	4
Number of strands in multiple	36	12
Number of parallel circuits	4	7
Kva. per coil	181	155
Total weight of copper in stator and field windings, tons	75	70

and introduced by J. Allen Johnson, electrical engineer of The Niagara Falls Power Co., the details having been worked out in conjunction with the manufacturers.

From the generators the leads, which are of copper bus construction, run to the shore wall of the power house and up an air shaft to the roof. From this point the leads are bare copper cables suspended from the overhanging gallery of the switchhouse at the top of the cliff. After passing through the oil switch, the 12,000-volt line continues to the step-up transformers, which are of the outdoor type located on the downstream side of the gatehouse for the new plant (See Fig. 8). The transformer steps the 12,000-volt power up to 66,000 volts for transmission to the Echota substation about three miles from the plant. In the substation the units are connected in parallel on the 66,000-volt bus and with the rest of the system.

There is an automatic oil switch between the generator and transformers and one switch between the step-up transformers and the busbars at Echota substation, and this is located on the substation end so that the transformers are part of the transmission line.

The principal interest in the transformers is their great size and high efficiency. They are rated at 22,000 kva. and are designed for 12,000 volts on the primary and 39,500 volts on the secondary, are of the oil-insulated water-cooled type, and are connected in delta on the primary and "Y" on the secondary for stepping the generator voltage up to 66,000. They have an overall height to the top of the insulators of 20 ft. The tanks are 10 ft. in diameter by 15 ft. high, in which the transformer is insulated with 5,675 gal. of oil. One transformer complete with oil weighs 159,000 pounds.

The efficiency of these transformers is remarkably high, as shown by the following, which is based on losses at 75 deg. C. measured by a wattmeter: Full load, 99.01; $\frac{7}{8}$ load, 99.083; $\frac{3}{4}$ load, 99.11; $\frac{1}{2}$ load, 99.09; $\frac{1}{4}$ load, 98.67 per cent.

Both the generators and transformers are protected with differentially connected relays. In case of trouble in a generator these relays function and disconnect it from the transformers and at the same time open the field switch. Trouble within the transformers will cause the oil switch at Echota substation to trip, also the switch between the generator and transformers and the field switch, thus preventing the voltage of the generator from rising excessively due to increased speed. As further protection against high voltage the generators are also equipped with over-voltage relays, which also open both generator oil switch and field switch.

Power wishes to express its appreciation to J. Allen Johnson, electrical engineer, the Niagara Falls Power Co.. W. J. Foster, assistant engineer, alternating-current engineering department, and A. E. Glass, alternating-current engineering department, General Electric Co.; and R. B. Williamson, engineer in charge of alternating-current design, Allis-Chalmers Manufacturing Co., for assistance rendered in the preparation of this article.

Fig. 8—Water-cooled, oil-insulated power transformers are installed in alcoves in the rear of the gatehouse at the top of the cliff

These transformers are rated at 22,000 kva., 12,000 volts on the primary and 39,500 on the secondary, and are connected in delta-star banks to step the generator voltage up to 66,000 volts.

Improving Financial Efficiency by Increasing Heat-Absorbing Capacity of the Steam Generating Unit

By H. M. VEHLING and H. S. CRAWFORD

A COMPARISON of representative modern steam-generating units consisting of combustion chamber, boiler, superheater and economizer will show that, as far as capacity is concerned, present-day practice differs little from that of five years ago. This condition exists regardless of the fact that there are means of proved merit available which will permit materially increasing the output of a steam-generating unit.

The purpose of this article is to call attention to the possibilities that exist for development in this field and to point out that the financial efficiency can be improved by loading each individual section of the steam-generating unit to its maximum safe working capacity. The items of reliability, flexibility and thermal efficiency are of course, to be incorporated in the design.

IN THE last analysis what counts is the total cost of a kilowatt-hour rather than the thermal efficiency of the station. Financial efficiency must therefore be the goal of good design and operation. The improvement of the financial efficiency of steam-power plants by simplification of design was discussed by the authors in the May 19 issue. In the present article they lay emphasis on boiler capacity in contrast to mere heating surface and predict that the search for true economy must result in loading each section of the steam-generating unit to its maximum safe working capacity.

The possibilities of higher heat-absorbing capacity of water-tube heating surface was appreciated by some long ago, but not universally recognized until the introduction of water-screen and side-wall heating surface. Boilers and economizers have undergone a considerable change for the better. Water screens, side-wall heaters, radiant-heat superheaters[1] and air preheaters have passed the stage of development and are now ready to be incorporated as a section of the steam-generating unit.

With the complications arising from the different rates of heat transfer per unit of surface of this various equipment, a new situation is encountered in the matter of determining the true capacity of a steam-generating unit. The application of the so-called "boiler rating" to a complete steam-generating unit is unsatisfactory as it does not clearly indicate the percentage of the total heat absorbed by each section of the unit. Today, regardless of the fact that a properly designed boiler can safely generate ten times as much steam per square foot of heating surface as when the rule was adopted, we still cling to the old definition of boiler horsepower based on heating surface, which has but little significance as a measure of capacity. It is readily seen that the B.t.u. basis is the only proper means for determining the capacity of a complete steam generator. The output of side-wall and water-screen heating surface therefore should not be confused with or added to that of the boiler, as has been done in some cases. This practice has resulted in claims of ridiculously high boiler ratings in cases where the total amount of heat absorbed by the boiler proper was not increased.

When considering the possibilities of increasing the capacity of the steam-generating unit, the boiler proper is the most important item. In selecting a boiler it is common practice to compare boilers of different manufacture and design on a heating-surface basis only, unwittingly disregarding differences in the steam-generating capacities when the factors of safety and dependability are the same. When one considers the large variation in the heat-transfer capacity of heating surface placed in the various portions of a boiler, the fallacy of this practice would be obvious, even if mention were made of the additional cost of providing space for tube clearance and the excessive installation costs for certain type boilers. The selection of a boiler should be governed by its capacity for absorbing the heat liberated in the furnace. Boilers should not be valued on a heating-surface-per-dollar basis. The maximum safe steam-generating capacity depends on the speed of water circulation, rate of heat transfer, amount of heating surface exposed to the radiant heat of the furnace, the extent of steam-locked tubes and restricted circulation. All these features vary greatly in the different commercially designed boilers that are on the market.

The boiler suitable for power-plant work should be capable of being forced at a rate much higher than that of present practice. If the tubes are kept free from steam bubbles, scale, oil or other deposits and filled with water in rapid and unreversible circulation, the temperature of the tubes is affected little by that of the flue gases. Under these conditions the tubes cannot be overheated, blistered or ruptured, so that the capacity of a properly designed boiler is limited only by the amount of heat that can be liberated in the combustion chamber. The practical capacity limit, however, is lower but still above that of present standards. When operating at the higher ratings, the auxiliary heat-absorbing equipment must be adapted to this condition in order to insure high thermal efficiency.

Reliability or the length of time a boiler can remain

[1] So many difficulties have been encountered in the development of the radiant-type superheater that many competent engineers have questioned their practicability. It is understood that the authors have in mind an improved type which they believe will overcome these difficulties.—Editor.

in uninterrupted service must be carefully considered, as the financial efficiency of the entire steam-generating unit and its alloted building and installation cost is dependent on the continuous operation of the unit. To obviate a large initial investment in spare equipment to take care of peak loads or periodic repairing, it is necessary to select a boiler having flexibility and high overload capacity, combined with reliability. From the foregoing it is readily seen that the factors of safety, capacity, thermal efficiency, quantity and quality of steam, depreciation, frequency of cleaning periods, repairs, etc., have an important bearing on the capital efficiency of the entire steam-generating unit. By selecting a boiler that can be safely and uninterruptedly operated at the higher ratings, together with auxiliary equipment to insure high thermal efficiencies, the capital efficiency is increased owing to a saving in boiler-heating-surface expenditure which also directly affects a saving in installation costs, building costs, etc.

Water Screens and Side-Wall Heaters

Water screens and water-tube walls have a tremendous capacity for absorbing heat. Steam-generating surface installed in this manner represents the maximum in commercial efficiency owing to the fact that its cost per unit of area should be little greater than that of regular boiler-heating surface although its heat absorbing capacity is several times as much. This type of heating surface has no detrimental effect on combustion efficiency. To take care of the larger amount of heat liberated in the combustion chamber, its size must be increased. Incidentally, it is to be noted that replacing the refractory lining with steel tubes will permit higher furnace temperatures, less excess air and highly preheated air. These increase thermal efficiency. Brickwork maintenance, the most troublesome operating difficulty, is thereby eliminated.

Radiant-heat superheaters[1] increase the heat-absorbing capacity per unit of surface over that of convection-type superheaters. In the opinion of the authors the financial efficiency is also increased, especially when the brickwork or arches are replaced by the superheater elements. This type of superheater also effects a saving in draft loss and maintains a more constant superheat temperature under load fluctuations than does the convection type unit.

Economizers and Air Preheaters

The economizer should be designed to take care of the increased gas volume and temperature resulting from the higher boiler ratings. Increasing the water and gas velocities over and through the tubes to the maximum practical limit will result in maximum heat transmission. However, it is assumed that in most installations this feature is taken care of. An air preheater should be incorporated in the design and so proportioned as to remove a large amount of the heat content remaining in the outgoing flue gases.

In view of the foregoing it may be said that increasing the rate of heat absorption per unit of surface undoubtedly increases the financial efficiency of the station. For example, two boilers of different design, having identical heating surface, will have different capacities. This difference in some cases may be as much as 100 per cent, with the same degree of reliability and safety. In this case it is obvious that one of the better boilers is equivalent to two of the low-capacity boilers. With its price equal to or slightly greater than that of the other boiler, a saving of approximately 50 per cent is effected in heating-surface expenditure for the same capacity. Furthermore, a secondary saving is realized in building cubical content due to using a boiler of smaller size.

In conclusion it may be said that the obstacles that have stood in the way of increasing the heat-absorbing capacities—namely, tube and refractory failures and poor thermal efficiencies at high ratings—have been overcome by the development of boilers with free and unrestricted circulation, water- and steam-cooled furnace walls which protect the refractory lining, and economizers and air preheaters which reclaim heat from the outgoing flue gases. It is a certainty that boiler plants of the near future will have a much greater heat-absorbing capacity per unit of installed heating surface than those of the present day and the increase in financial efficiency resulting therefrom will be an important factor in reducing the cost of power produced by the steam power plant.

It is not necessary along a curved surface to know the center of curvature or the radius in order to determine the effect of increasing the radius on the length of arc. Merely allow 6.28 in. per complete revolution per inch difference in radius. A practical example will make the meaning and use of this principle more clear. Take a 90-degree pipe bend of nominal 4 in. diameter (4.5 in. actual outside diameter). Suppose it is desired to know the length around the inside of the pipe bend, say from flange to flange, including the straight portions. It is awkward to run a tape around the inside of the bend. A tape around the outside reads 8 ft. 6 in., flange to flange. The inside distance will be less than this by $4.5 \times \frac{6.28}{4} = 7.06$ in., say 7 in. The 4 came from the fact that the turn is 90 deg. A 45-deg. turn would require $\frac{6.28}{8}$ in. and a return bend $\frac{6.28}{2}$. In the case of the 90-deg. bend the inside length would be 8 ft. 6 in. — 7 in. = 7 ft. 11 in.

Water hammer in steam pipes results from the impact of globules of water or wet steam that have been projected at high velocity through a portion of steam space in which the condensation has reduced the pressure. It is revealed by a sharp cracking or snapping noise in almost any pipe where there is rapid condensation of steam and where provision is not made for drainage, larger quantities of water thus gathering in a pipe system may be picked up and projected at intervals with enough velocity to rupture pipes or fittings. The remedy is to warm up the steam-pipe lines gradually, protect the sections not required as heating surfaces with heat-insulating coverings, and provide all pipes with a good pitch downward in the direction of steam flow, with suitable reliefs for the water at elbows, valves and low points in the pipe lines.

The idea that a cylinder will frost just before it is empty, is likely to be misleading. Frosting is caused by vaporization of the last small portion of liquid ammonia contained in the cylinder. If the end of the dipper pipe is close to the cylinder wall, this frosting will not occur, as practically all the ammonia will be discharged in liquid form.

How Grain Structure Indicates Steel Composition and Physical Qualities

What the Microscopic Study Reveals to the Metallurgist and How Physical Properties of Carbon Steels May Be Estimated Therefrom

By B. T. McMINN
Instructor in Mechanical Engineering, University of Washington

IRON and steel have many physical characteristics that have considerable interest for the engineer, but with which he is often unacquainted. Familiarity with these is helpful in making decisions as to material to be used for a given work, in tracing difficulties in working and in accounting for failures. This article is an attempt to illustrate some of these properties in as simple a manner as possible.

Steel is essentially an alloy of iron and carbon, the carbon having very important effects on the properties of the alloy and making it possible to vary the characteristics of the steel at will, within certain limits. Carbon is known as the "hardener" in steel; the hardening effect depending on, first, the percentage of it present, and second, on the form in which it is present. An understanding of the effect of carbon on iron is essential if we are to understand the wherefore of heat-treating.

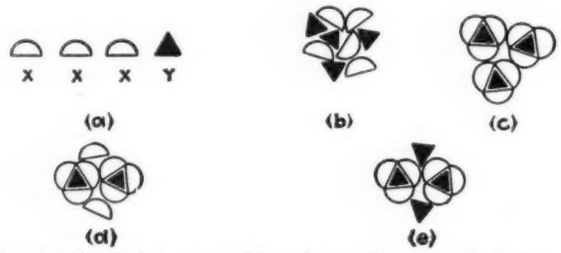


Fig. 1—Explaining combinations of two materials with a natural or eutectoid structure

Materials X and Y in proportion (a) may form a natural or eutectoid structure (c). A mixture (b) tends to form a eutectoid with the excess of X or Y left over at (d) and (e).

Iron is crystalline in nature, as is shown by the microphotograph, Fig. 2, and as can be proved in other ways. This photograph is of a piece of wrought iron, highly polished and etched with an acid, the magnification being 140 times as reproduced. The outlines shown are of grains of iron, each grain being made up of innumerable cubic crystals. These crystals are so small that they cannot be seen even with the aid of the microscope, and all are face-to-face in any one grain, but have no faces parallel with those in an adjacent grain.

The apparent grain outline is shown by the space left between cubes of adjacent grains where those cubes meet at odd angles. The size of the grain in the iron depends on the number of these cubic crystals in it, and that depends in turn, to some degree at least, on the treatment the iron has received. It is found that little can be done by heat-treating to change the grain-size of an iron after manufacture, but that because of the carbon present in steel the grain size in the latter may be varied markedly by suitable treatment.

Carbon in steel is not simply mixed mechanically with iron to make an alloy—it combines chemically with enough of the iron to make the iron carbide or cementite. It follows then that ordinary steel is really a mechanical mixture of cementite and iron and not of carbon and iron. This mixture of cementite and iron shows peculiar characteristics, however. The two materials will remain intimately mixed only in the definite proportion of 13 per cent cementite to 87 per cent iron.

If an attempt is made to mix them in other proportions, they will almost uncannily mix in finely divided

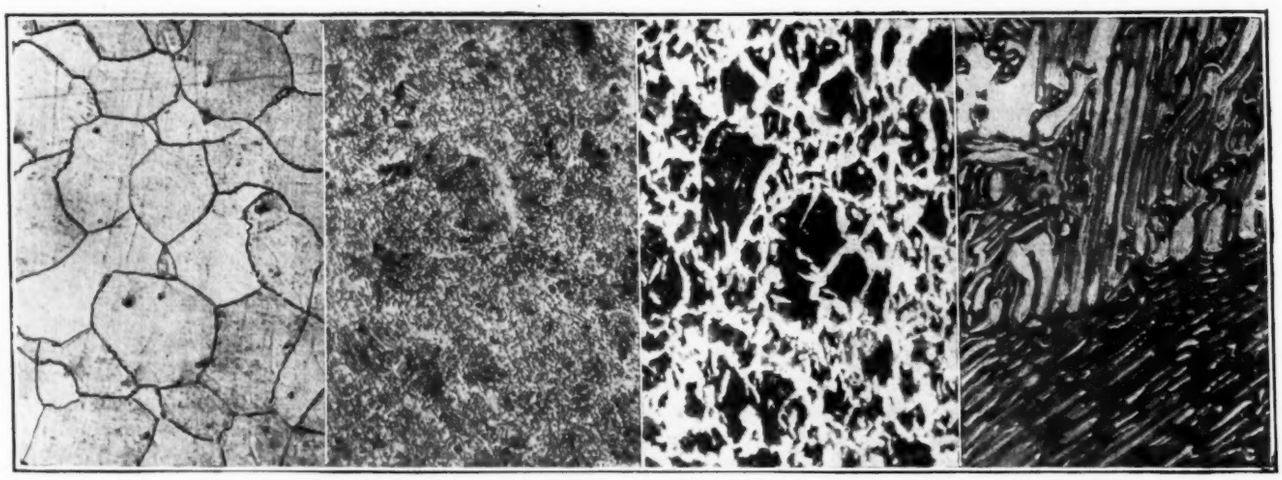


Fig. 2—Iron grains outlined

Fig. 3—Pearlite iron-cementite eutectoid

Fig. 4—Steel, showing iron white, and pearlite dark

Fig. 5—Pearlite, dark, iron light

particles in the definite proportions as given and force the material in excess of the required percentage to form as a separate constituent outside the mixture. This action would be expected if the combination of iron and cementite to make steel were chemical, but it can be easily shown that it is not. Science is at a loss to explain just how the peculiar mechanical mixture of iron and cementite can form with chemical precision, but similar phenomena (eutectoid solutions) occur in a few other instances, so the case is not without precedent.

The mixture of cementite and iron in a steel in the percentages of 13 cementite to 87 of iron is called pearlite (the iron-carbon eutectoid), so named because a microscopic section of a steel made up of pearlite shows the brilliant and beautiful coloring of mother-of-pearl. A steel containing 0.9 per cent carbon and 99.1 per cent iron (discounting impurities) is in the correct proportion to contain 13 per cent cementite, so that its microstructure will show pearlite, as in Fig. 3 (mag. 120 times) and Fig. 5 (mag. 1,120 times, light areas retouched).

In Fig. 5, a piece of pearlitic or eutectoid steel highly magnified, are groups of alternate black and white parallel lines. Each white line is the cut edge of a disk of cementite and each dark line is the cut edge of a disk-like layer of iron. A group of these alternating disks make up a grain of pearlite, which is polyhedral in shape. The polishing process has cut these grains of pearlite at odd angles, so what we see are sections through the disks. These disks or plates are parallel in any one grain, but those in one grain are not parallel to those in an adjacent grain. The grain

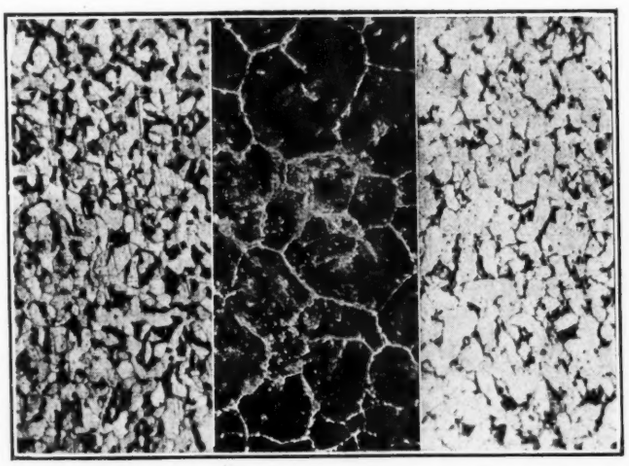


Fig. 6 — Steel, 0.25 per cent carbon *Fig. 7 — Steel, with 1.2 per cent carbon* *Fig. 8 — Steel, 0.1 per cent carbon*

outline in a pearlitic steel, shown better in Fig. 3, is due to this condition.

To illustrate the action in forming a normal steel not having exactly the eutectoid composition, let us study a simple example. Assume there are two materials X and Y as at (a) in Fig. 1, which are to be mixed (not chemically joined) in varying proportions. If they follow the law of ordinary solutions they become more or less uniformly mixed as in (b), with no particular arrangement followed. But suppose they exhibit eutectoid properties in that they will intimately mix themselves in finely divided particles only in the proportions of three of X to one of Y arranged for instance, as in (c) of Fig. 1. There a unit in the solution is three of X plus one of Y, and the whole solution is made up of multiples of this unit.

Suppose, however, that X and Y are not present in the proportions of three to one, but that there are four times as much of X as of Y; then the solution

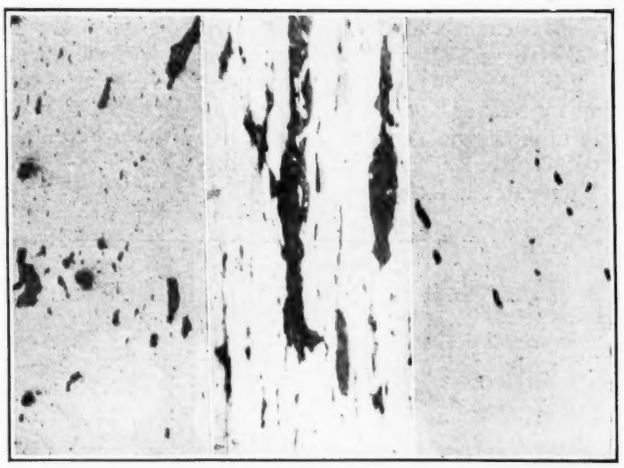


Fig. 9— Wrought iron transverse *Fig. 10— Wrought iron longitudinal* *Fig. 11 — Steel transverse section*

would be as shown at (d) of Fig. 1. The eutectoid unit will be formed as far as there is material in the proportion of three of X to one of Y (two units in this case), and whatever is left over will remain as it was before mixing and will appear separate from the eutectoid units.

Fig. 1, (e) is similar to (d) except that in (e) there is more of Y than is required to form the eutectoid, so the excess part there is Y instead of X as in (d). In either case (d) or (e) the material would show microscopically only two constituents, the eutectoid unit and the excess constituent. The fact that the eutectoid unit was actually two materials finely divided and uniformly mixed would be apparent only after the specimen was examined when highly magnified and by checking back on the chemical composition.

With the foregoing illustration in mind it will be easy to recognize the constituents of a steel that is not eutectoid in composition, that is, not of about 0.9 per cent carbon. Remember that the two materials paralleling X and Y in the illustration are iron and cementite (iron carbide) and that the eutectoid unit (c) in the example is pearlite.

If X is assumed to be the iron, a steel of less than 0.9 per cent carbon content would have constituents appearing under the microscope as in (d) of Fig. 1, pearlite and iron. Such a specimen is shown in Fig. 4, a piece of normalized steel of 0.5 per cent carbon (mag. 120 times). The dark constituent is pearlite, which could under sufficient magnification be made to look like that of Fig. 5. The light constituent is iron. The farther the composition gets from the eutectoid percentage the less pearlite, of course.

Fig. 6 is of a 0.25 per cent carbon steel (mag. 100 times). It is seen that the light constituent, iron, predominates. Fig. 8 is of a 0.1 per cent carbon steel,

still lower in carbon content and having less pearlite present.

If a plain-carbon steel had more than 0.9 per cent carbon in it, the two constituents shown on a microsection would be pearlite, the eutectoid and cementite. Such a specimen is shown in Fig. 7, a steel of 1.2 per cent carbon. There the dark constituent is pearlite and the white network, cementite.

A trained observer can determine the carbon content of a plain carbon steel of less than 0.9 per cent carbon by visual examination with the microscope with a possible error of about 5 per cent. The possible error with higher-carbon steels is greater. This accuracy compares favorably with that of chemical methods of determining the carbon content, and the method is much cheaper and considerably used.

This eutectoid characteristic of steel makes it possible to predict the strength of annealed plain-carbon steels with good accuracy from a physical examination under the microscope. Tests show pure pearlite to have a tensile strength of nearly 120,000 lb. per sq.in. Then if a microscopic section of a steel shows it to be all pearlite, we judge its strength to be 120,000 lb. per sq.in. with an error of ordinarily not over 5 per cent.

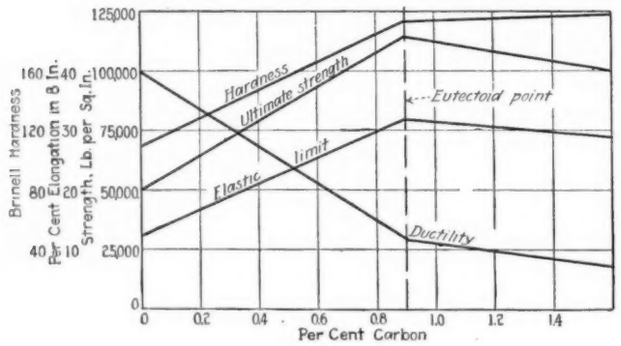


Fig. 12—Properties of annealed carbon steels as affected by the carbon content

If it shows all iron and no pearlite, its strength is 50,000 lb. per sq.in. If it is half pearlite and half iron, or in other words has about 0.45 per cent carbon in it, its strength will be half way between 50,000 and 120,000, or about 85,000 lb. per sq.in. In commercial irons and steels allowance for reduction in strength from these figures must be made owing to the diluting effect of any slag present.

The distinction between wrought iron and steel is made on several bases. Some authorities make it wholly on the method of manufacture. If the iron is never thoroughly molten during the process of manufacture, they call the product wrought iron; if the material is melted and poured into ingots during manufacture, it is steel. These differences in manufacture primarily affect the amount of slag and its mode of occurrence in the product, and those points are often cited as distinctions between iron and steel. Chemical composition is sometimes made the basis. If the product has very low carbon content, say less than 0.05 per cent, it would be called iron; if higher in carbon content, it would be called steel.

The first and last of these distinctions sometimes conflict. Puddled iron, or wrought iron, manufactured by being brought to a pasty state but not being actually molten, sometimes contains considerable carbon and hence might be called steel; but it is not, because of the mode of its slag occurrence and its other physical properties. Bessemer steel is sometimes made with little carbon in it and therefore might be called iron, but this is not because it has essentially steel characteristics.

Because of the fact that during the manufacture of wrought iron it is never thoroughly molten, the slag in it does not all rise to the surface where it can be skimmed off, so remains in fairly large quantities in the finished material. Before the iron is rolled to shape, the slag in it is in roughly spherical globules, but the rolling process elongates it into the form of tubes or seams, running in the longitudinal direction of the piece.

Sections of a piece of wrought iron are shown in Figs. 9 and 10. The transverse section, Fig. 9, has cut across the slag tubes or seams so the slag appears in nearly round blotches. The longitudinal section, Fig. 10, shows how the threads run throughout the length of the bar or plate. Because these threads are continuous and of considerable size and number in wrought iron, its strength is not so consistent as that of steel. Many times these slag seams are so large that they can be seen with the naked eye on a fracture of the iron. (The grain outline does not show in these figures because the specimen is unetched. By referring to Fig. 2, the reader will see how the slag appears on an etched lateral section.)

Fig. 11 is of a piece of 0.5 per cent carbon steel, unetched. The dark streaks are slag inclusions. It is seen that the slag occurs in steel in smaller particles than in wrought iron, and hence its effect in breaking up the continuity of the structure is not nearly so pronounced as in iron, even though the amount of slag may be the same in the two materials.

There is very poor bond between the slag and metallic constituents in iron and steel, so the slag reduces the strength quite markedly if it breaks the continuity of the metallic structure very much. In the process of making steel the material is thoroughly molten and most of the slag rises to the top and is skimmed off. The part that remains is finely divided, so that when the steel is rolled the threads of slag are much smaller and shorter, though sometimes there are more of them.

One criterion of the quality of a steel is the amount of slag it contains and its mode of occurrence. Usually, the higher the carbon content of a steel the more attention paid to quality in general and particularly to slag elimination. The higher qualities of steel are usually made, or at least finished, by the crucible, cementation, or electric furnace processes and are commonly almost free from slag.

Steels are classified rather loosely as to carbon content as follows: Low-carbon steel, or mild steel, 0 to 0.2 per cent carbon; medium-carbon, or machine steel, 0.2 to 0.5 per cent carbon; tool steel, from 0.5 to about 1.25 per cent; spring steel, 0.7 to 1.5 per cent carbon. Commercial tool steel commonly has a carbon content of about 0.8 per cent.

Fig. 12 is a set of curves showing the approximate relations of elastic strength, maximum strength, ductility and hardness of plain-carbon steels in the annealed state, as a function of the amount of carbon they contain.

Microphotographs for this article were made by the author in the laboratory of the Mechanical Engineering Department, University of Washington. Except where otherwise stated, magnifications are 100 times.

Bid Schedules on Mechanical Auxiliaries in Detroit Municipal Plant

Boiler-Feed Pumps, Mechanical Draft Equipment, Bridge Cranes, Condenser Tubes and Ferrule Stock

IN THE past *Power* has presented the tabulated bid data on the primary and auxiliary equipment of the Morrell Street plant that is being erected by the Public Lighting Commission of the City of Detroit, as they have become available. As the cost figures and engineering data contained in these tabulations have been received with interest, the practice has been continued. Through the courtesy of Smith, Hinchman & Grylls, consulting engineers, there are included in the present installment the tabulations on the boiler-feed pumps, the mechanical-draft equipment, the bridge cranes and the condenser tubes and ferrule stock. The contracts were awarded as follows: Boiler-feed pumps, De Laval Steam Turbine Co.; mechanical-draft fans, Bayley Manufacturing Co.; cranes, Whiting Corporation; condenser tubes and ferrule stock, Bridgeport Brass Co.

To make the tables more readily understandable the principal data on the equipment, such as number, size and operating details, are given in the following summaries:

Boiler Feed Pumps

Five boiler-feed pumping units are to be furnished. Units Nos. 1, 2 and 3 are each to consist of two centrifugal pumps, connected in series and mounted on a common sub-base with the driving motor, a direct-

Table I—Tabulation of Bids on Boiler Feed Pumps

		Allis-Chalmers Mfg., Co.		De Laval Steam Turbine Co.				Chas. McIntosh & Co.		Bethlehem Shipbuilding Corp.	
I Bidder											
II Address		Millwaukee, Wis.		Trenton, N. J.				Detroit		Elizabeth, N. J.	
				Bid No. 1		Bid No. 2		Not in Accordance With the Specifications		Only Partial Bid	
III Price		$49,000.00		$32,900.00		$33,800.00		$32,950.00		$13,149.00	
			Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1. Delivery time, weeks		28	..	20	10	.....	..	10	..	12	15
2. Erection time, weeks		12	..	4	10	.....	..	3	..	.....	..
3. Net weight of units Nos. 1, 2 and 3. (lb., each).	A. Pumps	17,500	..	8,000	10	.....	..	12,000	..	.....	..
	B. Sub-base	7,000	..	6,000	10	.....	..	.....	..	.....	..
	C. Total	24,500	..	14,000	10	.....	..	12,000	..	.....	..
4. Net weight of units Nos. 4 and 5 (lb. each).	A. Pumps	8,100	..	7,500	10	7,500	..	10,000	..	.....	..
	B. Turbine	5,500	..	2,500	10	3,000	..	3,500	..	.....	..
	C. Sub-base	3,500	..	4,000	10	4,500	..	.....	..	.....	..
	D. Total	17,100	..	14,000	10	15,000	..	13,500	..	15,200	10
5. Hp., rpm. and efficiency when pump (Nos. 1, 2 and 3) is discharging 625 gpm. 315 deg. F. against 550 lb.	A. Horsepower	259	..	259	1	.....	..	254	..	.....	..
	B. speed, rpm	1,150	..	1,150	1	.....	..	1,135	..	.....	..
	C. Efficiency, per cent	67	0	67	1	.....	..	68	..	.....	..
6. Hp., rpm. and efficiency when pump (Nos. 1, 2 and 3) is discharging 400 gpm. 285 deg. F. against 550 lb.	A. Horsepower	273	..	188	1	.....	..	191.5	..	.....	..
	B. Speed, rpm	1,175	..	1,080	1	.....	..	1,090	..	.....	..
	C. Efficiency, per cent	67	0	62	1	.....	..	61	..	.....	..
7. Hp. and rpm. when pump (Nos. 1, 2 and 3) is maintaining a discharge press. of 475 lb. with no discharge, water at 290 deg. F.	A. Horsepower	135	..	80	1	.....	..	74.5	..	.....	..
	B. Speed, rpm	1,083	..	1,030	1	.....	..	990	..	.....	..
8. Hp., rpm. and efficiency of pump and steam consumption of turbine when unit Nos. 4 and 5 are discharging 1,000 gpm. 100 deg. F. against 550 lb. with 360 lb. steam press. and 255 deg. F. superheat and exhausting against 17 lb. absolute.	A. Horsepower	477	..	464	..	.....	..	459	..	515	2
	B. Speed, rpm	1,800	..	1,900	..	.....	..	2,000	..	4,550	3
	C. Efficiency, per cent	68	..	70	..	.....	..	70	..	62.6	1
	D. Steam consumption lb. per Bhp.	30	..	39	..	29.1	..	45	..	25.2	2
9. Number pumps each—units Nos 1, 2 and 3		2	..	2	..	2	..	1	..	.....	..
10. Number stages per pump units Nos. 1, 2 and 3		6	..	5	..	5	..	8	..	.....	..
11. Number pumps each—units Nos, 4 and 5		One	..	One	..	One	..	One	..	One	..
12. Number stages per pump—units Nos. 4 and 5.		6	..	6	..	6	..	8	..	One	..
13. Make of pump		Allis-Chalmers		De Laval		De Laval		Manistee		Weir	

current, variable-speed machine. At 1,200 r.p.m. each pumping unit will be capable of delivering 625 gal. per min., of water against a discharge pressure of 550 lb. gage, with an efficiency of not less than 66 per cent, when operated under the following suction pressures and the corresponding water temperatures:

Pressure, lb. gage	10	25	50	75
Temperature, deg. F.	225	255	285	315

Of units Nos. 4 and 5, each is to consist of a centrifugal pump directly connected to a steam turbine. With a suction lift of 15 ft. each of these pumps is to be capable of delivering 1,000 gal. per min. of water at a temperature not exceeding 100 deg. F., against a discharge pressure of 550 lb. gage, when the turbine is supplied with steam at 360 lb. gage pressure and operating at a speed not exceeding 2,000 r.p.m. At lower steam pressures down to a minimum of 200 lb. gage and at the resultant turbine speeds, the units are to be capable of delivering the rated capacity of water against a discharge pressure of 190 lb. in excess of the pressure of the steam supplied to the turbines.

The turbines are to be of the single-wheel velocity-stage type and of sufficient size to operate the pumps at the capacity specified when the steam pressure at the turbine throttle varies from 200 to 365 lb. gage and the superheat from 100 to 265 deg. F. The machines are to be capable of standing a total steam pressure of 400 lb. and a total temperature of 730 deg. F.

All pumps are to be of the centrifugal, hydraulically balanced, multi-stage volute type.

Mechanical Draft Equipment

Six primary air fans, six secondary air fans and six induced-draft fans are to be furnished. The primary air fans are to be of the single-inlet type, each being capable of discharging 8,500 cu.ft. per min. of air at a temperature of 250 deg. F. against a static pressure of 20 in. of water with a speed not greater than 1,300 r.p.m. and a power consumption not exceed-

Table II—Schedule of Bids of Mechanical Draft Equipment

					Amer. Blower Co.		Bayley Mfg. Co.		Green Fuel Econ. Co.		N. Y. Blower Co.		Sturtevant Co.	
I. Bidder														
II. Address					Detroit		Milwaukee		Beacon, N. Y.		Chicago		Boston	
III. Price					$30,300.00		$22,760.00		$40,488.00		$39,700.00		$32,008.00	
						Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1. Delivery time, weeks					10	10	1st unit, 30 days Bal. 30 days	.....	13	.....	18	.....	12	2
2. Erection time, weeks					6	15	45 days	.....	9	.....	12	.....	6	2
3. Net weight per primary air fan, lb.					2,800	10	2,380	10 per cent	3,100	.....	3,120	.....	5,550	.....
4. Net weight per secondary air fan, lb.					9,000	5	8,320	5 per cent	9,500	.....	6,370	.....	10,000	.....
5. Net weight per induced draft fan, lb.					10,100	5	11,640	5 per cent	14,500	.....	14,235	.....	12,660	.....
	C.f.m. Air	Deg. F.	Static Press. In. Water											
6. Speed—primary air fan.	2,400	200	13.0	R.p.m.	985	2.5	1,030	3 per cent	1,005	2.5	1,040	.....	990	.....
	3,700	200	14.5	R.p.m.	1,040	2.5	1,060	3 per cent	1,051	2.5	1,090	.....	1,050	.....
	4,500	200	16.0	R.p.m.	1,100	2.5	1,120	3 per cent	1,104	2.5	1,180	.....	1,130	.....
	8,500	250	20.0	R.p.m.	1,320	2.5	1,290	3 per cent	1,271	2.5	1,320	.....	1,320	.....
7. Horsepower input to fan.	2,400	200	13.0	Hp.	12	2.5	9.5	1 hp.	14	2.5	10	.....	19.9	.....
	3,700	200	14.5	Hp.	16	2.5	15	1 hp.	19	2.5	15.5	.....	25	.....
	4,500	200	16.0	Hp.	20	2.5	19	1 hp.	24	2.5	18	.....	28.5	.....
	8,500	250	20.0	Hp.	40	2.5	42	1 hp.	47	2.5	43	.....	50	.....
8. Speed—Secondary air fan.	54,000	70	3.0	R.p.m.	690	2.5	668	3 per cent	685	2.5	780	.....	660	.....
	23,600	70	0.65	R.p.m.	318	2.5	303	3 per cent	310	2.5	350	.....	322	.....
	20,700	70	0.50	R.p.m.	280	2.5	265	3 per cent	272	2.5	310	.....	296	.....
9. Horsepower input to fan.	54,000	70	3.0	Hp.	40	2.5	40	1 hp.	40	2.5	46	.....	36	.....
	23,600	70	0.65	Hp.	4	2.5	3.7	1 hp.	4	2.5	4.5	.....	3.3	.....
	20,700	70	0.50	Hp.	2.75	2.5	2.5	1 hp.	3	2.5	3	.....	2.23	.....
	Lb. per Hr. Flue Gas	Deg. F.	Static Press. In. Water											
10. Speed—induced draft fan.	260,000	635	5.25	R.p.m.	670	2.5	608	3 per cent	670	2.5	670	.....	648	.....
	190,000	285	6.0	R.p.m.	565	2.5	329	3 per cent	605	2.5	555	.....	557	.....
	116,000	240	2.0	R.p.m.	320	2.5	183	3 per cent	341	2.5	350	.....	315	.....
11. Horsepower input to fan.	260,000	635	5.25	Hp.	175	2.5	164	1 hp.	168	2.5	170	.....	174.5	.....
	190,000	285	6.0	Hp.	100	2.5	100	1 hp.	113	2.5	97	.....	90.0	.....
	116,000	240	2.0	Hp.	17	2.5	17.5	1 hp.	22	2.5	21	.....	17.1	.....

ing 50 hp. Each of the fans is to be directly connected to a direct-current variable-speed motor and at corresponding lower speeds is to be capable of discharging 3,700 cu.ft. per min. of air at a temperature of 200 deg. F. against 14½ in. of water static pressure with a power consumption not exceeding 25 hp.; and 2,400 cu.ft. per min. of air at 200 deg. F. against 13 in. static pressure with a power consumption not greater than 20 hp.

The secondary air fans are to be of the double-width, double-inlet, multi-blade type. Each fan is to be directly connected to a variable-speed motor and have a capacity of not less than 54,000 cu.ft. per min. of air at 70 deg. F. against a static pressure of 3 in. of water with a speed between 650 and 780 r.p.m. and a power consumption not greater than 40 hp. When the fan is discharging 23,600 cu.ft. per min. at corresponding speed against 0.65 in. static pressure, the power consumption is not to exceed 4¼ hp.

Induced-draft fans are to be of the single-width, double-inlet, multi-blade type, each capable of exhausting 260,000 lb. per hour of flue gases at a temperature of 635 deg. F. against a static pressure of 5¼ in. of water, with a speed between 640 and 670 r.p.m. and a power consumption not greater than 175 hp. At a corresponding lower speed each fan is to be capable

Table III—Bridge Cranes for Turbine Room and Coal Handling

I. Bidder				Manning Maxwell & Moore		Milwaukee Elec. Crane & Mfg. Co.		Northern Eng. Works		Pawling Harnischfeger Co.				Toledo Crane Co.		Whiting Corp.	
II. Address				Muskegon, Mich.		Milwaukee, Wis.		Detroit, Mich.		Milwaukee, Wis.				Toledo, Ohio		Harvey, Ill.	
										Bid No. I		Bid No. II					
III. Price (turbine room cranes)				$28,265.00		$26,500.00		$26,265.00		$29,250.00		$34,150.00		$35,500.00		$22,890.00	
IV. Price (both cranes)				37,640.00		36,450.00		36,605.00		39,000.00		44,000.00		47,400.00		32,520.00	
					Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1. Delivery time, weeks				12	5	....		14	25	12	25	12	25	20	10	8	25
2. Erection time, weeks				3	5	....	....	3	25	4	25	4	25	8	....	5	25
3. Net weight (lb.)	A. Turbine room crane			238,700	....	194,500	....	220,000	10	186,000	....	218,000	....	220,000	....	202,000	....
	B. Track hopper crane without bucket			35,900	....	40,270	....	38,600	10	39,600	....	39,660	....	37,100	....	40,000	....
	C. Grab bucket			....	....	6,000	....	6,000	5	6,800	....	6,800	....	5,900	....	5,000	....
4. Maximum wheel load (lb.)	A. Turbine room crane			86,000	....	81,000	....	83,000	10	80,000	....	85,000	....	80,000	....	80,000	....
	B. Track hopper crane			16,000	....	21,000	....	22,000	10	20,000	....	20,000	....	19,000	....	20,000	....
5. Motor hp. and full load speed	A. Turbine room crane	Main hoist	Hp.	60	....	50	....	60	....	50	....	60	....	60	....	60	....
			R.p.m.	855	....	900	....	900	....	870	....	720	....	855	....	900	....
		Aux. Hoist	Hp.	25	....	30	....	30	....	25	....	30	....	40	....	30	....
			R.p.m.	670	....	1,200	....	900	....	1,120	....	1,200	....	1,125	....	900	....
		Bridge	Hp.	60	....	50	....	60	....	50	....	60	....	60	....	40	....
			R.p.m.	855	....	900	....	900	....	870	....	720	....	855	....	900	....
		Trolley	Hp.	25	....	30	....	20	....	25	....	30	....	30	....	20	....
			R.p.m.	670	....	1,200	....	1,200	....	1,120	....	1,200	....	1,140	....	900	....
	B. Track hopper crane	Main hoist	Hp.	40	....	40	....	80	....	40	....	40	....	40	....	40	....
			R.p.m.	840	....	1,140	....	900	....	900	....	900	....	1,125	....	900	....
		Bridge	Hp.	15	....	15	....	15	....	15	....	15	....	15	....	15	....
			R.p.m.	810	....	1,120	....	1,200	....	1,200	....	1,200	....	810	....	900	....
		Trolley	Hp.	5	....	7.5	....	10	....	7	....	7	....	7.5	....	10	....
			R.p.m.	1,080	....	1,130	....	1,200	....	900	....	900	....	810	....	900	....
6. Diameter of truck wheels (in.)	A. Turbine room crane			30	....	27	....	30	....	27	....	27	....	28	....	24	....
	B. Track hopper crane			18	....	21	....	18	....	21	....	21	....	18	....	20	....

Table IV—Bid Schedule of Condenser Tubes and Ferrule Stock

I. Bidder	American Brass Co.		Bridgeport Brass Co.		Seovill Mfg. Co.		Wheeler C. & E. Co.	
II. Address	Waterbury, Conn.		Bridgeport, Conn.		Waterbury, Conn.		Carteret, N. J.	
II. Price (by cast shell process)	$43,365.99		$39,195.00		.....		$44,920.00	
III. Price (by cupping process)	46,914.63		.....		47,200.00		.....	
		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1. Time of delivery of condenser tubes after entering into contract, (weeks)	40	.....	27	.....	6	.....	16	.....
2. Time of delivery of ferrule stock after entering into contract, (weeks)	4	.....	4	.....	4	.....	4	.....

of exhausting 116,000 lb. per hour of flue gas at a temperature of 240 deg. F., against 2 in. static pressure, with a power consumption not greater than 17.5 hp.

Each of the fans is to be directly connected to a direct-current variable-speed 50-hp. motor at one end of the shaft and to a 720-r.p.m. synchronous speed alternating-current induction motor at the other end. The direct-current motor is to operate the induced-draft fans up to the capacity of the motor and the alternating-current motor at higher capacities.

Bridge Cranes

Two cranes are to be furnished, one in the turbine room for erecting and maintaining the machinery, and the other over the track hopper for unloading coal from railway cars that cannot be dumped. The cranes are to be of the four-motor, traveling, bridge type, capacities, spans and full-load speeds being given in the following table:

Crane	Turbine Room	Track Hopper
Capacity of main hoist, tons	100	5
Capacity of auxiliary hoist, tons	15	None
Capacity of bridge, tons on hook	100	10
Approximate span, ft	80	30
Main hoist speed, ft. per min	5	150
Auxiliary hoist speed, ft. per min	20	
Trolley speed, ft. per min	100	150
Bridge speed, ft. per min	100	200
Hook lift, ft	70	30
Length of runway, ft	195	70

All motors are to be alternating-current 440-volt three-phase 60-cycle machines, installed complete with wiring, circuit breakers and controllers of the standard crane type, with switchboards of the inclosed safety type. A number of minor accessories are to be furnished as part of the crane installations.

Condenser Tubes and Ferrule Stock

Condenser tubes to the number of 16,000, No. 18 B.w.g., seamless drawn, 1 in. outside diameter and 20 ft. 3 in. long are to be furnished. These tubes will be rolled into the tube sheets at one end and ferrule packed at the other.

Of the ferrule stock, 1,350 lin.ft. of No. 8 B.w.g. seamless-drawn tubing, 1¼ in. outside diameter, is to be furnished.

All condenser tubes and ferrule stock are to be made by the cast shell or cupping process at the option of the commission. The materials are to conform to the following chemical composition: Copper, 70 per cent min.; tin, 0.9 per cent min.; iron, 0.06 per cent max.; lead, 0.075 per cent max.; zinc, remainder.

Sines and Tangents for the Practical Man

It is a pity that the uses of sines and tangents are not taught in the grammar schools instead of being reserved for the trigonometry courses of the last year of high school or the first in college. Sines and tangents are to trigonometry what a saw and hammer are to architecture. No one feels that a man should be refused instruction in the use of saw and hammer just because he does not plan to study architecture.

Saw and hammer are no easier to manipulate than are sines and tangents in their simplest and most important applications. Lack of knowledge of "mathematics" need hinder no practical man who is willing to spend half an hour learning the ropes.

Every engineering handbook has a table of sines and tangents of angles, sometimes called "natural" sines and tangents. Frequently, "sine" is abbreviated to "sin" and tangent to "tan." Thus "sin 30 deg." means "sine of 30 degrees," and "tan 42 deg." means "tangent of 42 degrees." These are called "functions" of the angle, which is the mathematical way of saying that they are values that depend on the angle and on nothing else. The tables often give other functions such as cosine, cotangent, secant and cosecant, but none of these is necessary for practical work; the sine and tangent will handle every case.

With the aid of sines and tangents one may measure or lay out any angle without a protractor, using only straight-edge, scale, square and compass (occasionally).

The meaning of the terms *sine* and *tangent* may best be explained in connection with a sloping roof. Suppose a roof rises 0.4 ft. for every foot measured along the slant. The angle the roof makes with the horizontal is said to have a sine of 0.4. Taking one side of an angle as a base line, it is then evident that the sine is merely the rise in feet (or other unit) for each foot (or other unit) measured along the slant. According to a table of sines and tangents, 23 deg. 30 min. has the desired sine (0.4) and is therefore the angle of slope of the roof.

Another man measuring the same roof would find that the rise was 0.435 ft. for each foot measured *horizontally*. This figure is called the tangent of the angle. The tangent may then be defined as the rise in feet per foot measured horizontally.

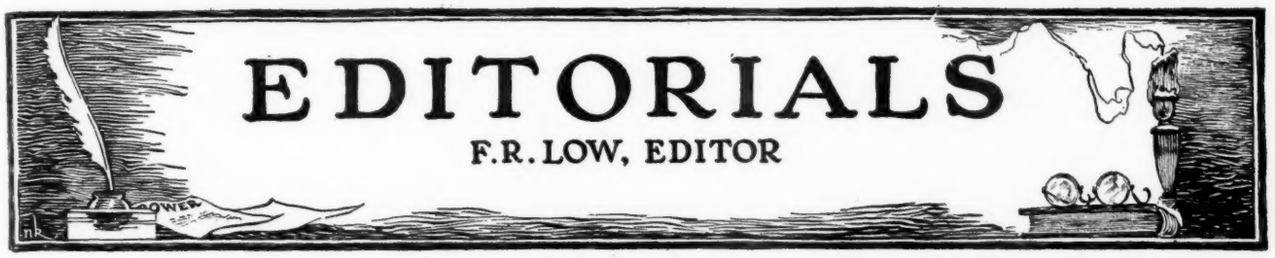
Evidently, any existing angle may be measured in either of these two ways. Similarly, any desired angle may be plotted easily from its sine or tangent.

When grinding commutators, finely divided dust from the grinding wheel penetrates bearing caps, oil guards, ventilating ducts and many places where least expected. The air currents often draw this dust into the windings and insulation of a machine. If the operator blows out the machine with compressed air and feels assured of protection by the clouds of dust produced, he is likely to be misleading himself. Dust from the wheel is quite easily removed by this means, but copper dust is too heavy to be eliminated from confined or remote lodging places by compressed air. Wiping with a cloth is better, but preventing the dust from reaching critical points is the surest and easiest course to pursue.

When using double-sling chains with heavy loads care should be taken that the angle between the two legs of the chain is not so large that the chain is loaded beyond its strength. A sling safe for 10,000 lb. load with the legs vertical or nearly so, is safe for only 8,650 lb. where the angle between the two legs is 60 deg. For a 90-deg. angle the safe load would be 7,050 lb., for 120 deg. 5,000 lb. and for 150 deg. only 2,580.

The accuracy of a slide rule is proportional to its length. With an experienced operator the results obtained by a single multiplication or division on a ten-inch rule can be trusted to one part out of 500 when the lower scales are used and one part out of 250 with the upper scales. Twice this accuracy may be obtained with a 20-in. rule.

A pound of coal contains several times as much energy as a pound of nitroglycerin.



Standardized Equipment and Reduced Cost

ONE is sometimes led to question whether, in the continual strife for increased efficiency in large power stations, the actual operating saving always warrants the cost involved; especially in view of the high amortization rate incident to such rapid evolution in design as the last few years have witnessed.

Not that engineers are prone to disregard initial costs when figuring the possible savings, but their calculations are usually based on the cost of equipment under present practice and not on what costs might be if greater standardization were carried out.

Most power-plant equipment is built and not manufactured, from a production viewpoint. This is largely because the designer too often insists on special layouts for which special equipment is usually required; all of which adds to the purchase price. Moreover, to the manufacturer it means much in the way of development, extra service and often replacement of parts. These tend to reduce his profits and add to his worries.

Obviously, the idea should not be carried to the point of stagnating progress, but there are many cases where standard equipment would suffice in place of special designs with equivalent results, and in others with so little difference as not to justify the extra expense.

Industry has strongly indorsed Secretary Hoover's campaign for the elimination of waste, and here is an opportunity to apply the principle to the power-plant field.

Using Exhaust Steam

IT IS very satisfactory to notice the increasing attention that is being paid to the use of exhaust steam.

For years *Power* has been preaching its potentialities and condemning the throwing of great quantities of heat away in the exhaust of a condensing engine while burning extra coal to make steam for heating and for manufacturing processes.

What would be thought of a man who let all the available water pass through the turbines and discharge into the tailrace and then used expensively produced power to pump enough of it back to supply the washing and other water-consuming processes of the mill?

The cases are similar. Just as the mill man might better take off all the water required at the level that would let it flow to his work, so might he better take off the heat that he requires at a temperature level that will allow it to serve his purpose.

If he draws off much water under full head, he had better draw it off through a turbine than a valve, getting advantage of its partial fall instead of letting it generate useless velocity.

If drawing off the water at the intermediate level restricts his power, he can restore it if he can raise the dam. In the case of the steam he can raise the pressure.

Where there is a considerable use for heat at any temperature between that of the boiler and the condensate, it does not pay to run a condenser.

The cheapest known process of developing power from fuel is to make it from the fall of heat to a temperature level that will still permit the rejected heat to be utilized.

It is practically a one hundred per cent process.

The editor saw recently turbines in a paper mill exhausting at over one hundred pounds pressure, the exhaust being used in the digesters.

The turbine reduces the utilization of exhaust steam to the extreme of simplicity. With the reciprocating engine, bleeding was limited to the receiver of the compound. With the turbine, steam can be taken off at as many pressures and temperatures as may be required and in any amounts, the rest passing to the condenser.

The possibilities in this direction should be exhausted before steam is sent to the condenser or a steam power plant abandoned for the purchase of current, which is only doing the same thing by a circuitous route.

How To Make a Brewery Pay

IT IS commonly held that the advent of prohibition has practically destroyed the value of buildings and equipment worth untold millions. As a matter of fact, many brewery properties are now finding limited employment in such occupations as the manufacture of "near beer" and of ice. Their more complete utilization is a matter of considerable economic importance.

Passing by the obvious but limited field of legal-beverage manufacture, and assuming all specialized brewing equipment to be junked, the principal assets of a typical brewery boil down mainly to these: Land, empty buildings, a boiler plant, engines and generators, refrigerating machinery and ice plant, garages or stables. The matching of these facilities by corresponding commercial demands in an occupation more interesting and certainly far more profitable than the solving of crossword puzzles. Let the imagination start working and possibilities begin to appear. The empty buildings call for tenants. Tenants require service. What tenants can use the available facilities?

The availability of live and exhaust steam brings to mind the fact that all tenants need heat for buildings, but some (such as milk plants, canneries, laundries, etc.) have additional use for process steam and hot water. Electricity can be used by all tenants for light and by some for power also. Refrigeration suggests cold storage, ice companies, fur storage, milk cooling, food freezing, etc.

After a little study of this sort the property ceases to appear as a forlorn hope and takes on the character of a high-grade speculative investment. If the various buildings can be rented to tenants carefully selected on

the basis of their ability to consume steam (particularly exhaust steam), hot water, electricity and refrigeration, the possibility of a profitable composite business looms up. That this is no "pipe dream" is proved by the achievements of the United Refrigeration & Terminals Company in New York City. As recounted on page 82, this company has already converted a post-Volstead "white elephant" into a beehive of industries. Hardly two years old, the outfit is already a good money maker with every promise of improvement in this respect as the equipment is gradually modernized and operation tuned up to concert pitch.

Granted a management combining business acumen with engineering skill—the sort of organization that can secure desirable tenants, set up intelligent methods of measuring and charging for service, and maintain efficient, dependable service—there is many another brewery property that could be turned into a consistent producer of profits.

An Interesting Comparison

AN OUTSTANDING feature of waterwheel generators is their wide diversity of design. The speeds that steam-turbine driven alternators operate at are generally limited to thirty-six hundred and eighteen hundred for sixty-cycle machines and fifteen hundred revolutions per minute for twenty-five cycle machines, except in some few cases where lower speed may be used. Waterwheel generators are usually for comparatively low speeds, generally between sixty and two hundred revolutions per minute, although in high-head installations higher speeds may be used. Within the latter range a wide variety of speeds may be used. For example, between sixty and two hundred revolutions per minute there are forty-three different speeds that may be used to meet the requirements of a sixty-cycle system and eighteen for twenty-five cycles.

In the high-speed range of twelve hundred to thirty-six hundred revolutions per minute, such as used for steam turbines, there are only three speeds that can be used for sixty-cycle and one for twenty-five-cycle generators. This is one of the reasons why there are so few speeds used for steam-turbine driven alternators and such a wide variety for waterwheel generators. For hydraulic turbines the designer and manufacturer have practically a free hand in selecting a speed best suited to the turbine for the particular job, whereas for the steam turbine there is practically only one speed available.

With steam plants it is possible to make the plant almost any desirable capacity and select standardized units to provide this capacity. With water power, if a given site is to be developed to its economical limit, this places a given capacity on the plant, and then it becomes a matter of selecting units to suit best the capacity. As practically no two water-power sites have the same capacity or the same volume of water or head, it is not difficult to see why there should be a wide diversity in the design of waterwheel generators.

When two manufacturers design and build generators for the same speed and capacity to be installed in the same plant, one might expect that the machines would be quite similar in mechanical details, but there may be a wide diversity in the design, as indicated in the article in this issue describing the sixty-five thousand kilovolt-ampere generators installed at Niagara Falls. The generator built by one manufacturer weighs over two hundred thousand pounds less than that built by another. Even in the weight of copper there is about ten thousand pounds difference in the two machines. As the machines have to meet the same rigid specifications as to efficiency, this great difference in weight shows that there is a wide divergence in opinion as to the mechanical design of waterwheel generators. This is further emphasized in the flywheel effect, which is about thirty-two per cent greater in one make of machine than in the other. These two makes of machines represent the best that the present state of the art in waterwheel design has to offer, and the wide differences in the mechanical and electrical details make an interesting comparison of two designs.

Coal by Prescription

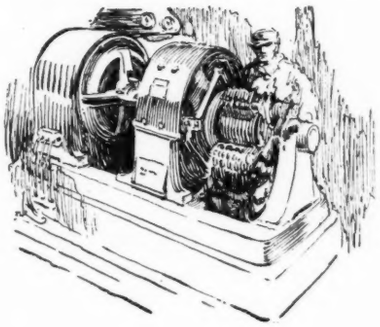
"THERE is another phase of the subject of coal utilization which offers opportunity for expert treatment; namely, the adaptation of fuel to situations, perhaps I might say the prescription of fuel for any given use. At the present time the selection of fuel is largely a matter of habit, influenced of course by price. It should be possible, assuming proper control of the machinery of production and distribution, to select for any given case the most economical fuel. Doubtless, in some cases the best results would be obtained by the blending of fuels. Though this prediction seems visionary to those who see only the present condition of the coal industry, I think it is not unreasonable to expect that the future will see such prescription of fuels and such blending of fuels where at the present time little is attempted beyond the adaptation of methods of burning to the fuels at hand."

There is food for thought in this quotation from an article on fuel engineering in the May issue of the *Journal of Engineering Education*, by C. M. Young, professor of mining engineering, University of Kansas. That the average coal dealer of the present day is unfitted to prescribe coal or coal mixtures exactly suited to the needs of his various "patients," goes without saying. Neither can this service be performed to the best advantage by the mining companies, because of their special interest in the sale of certain grades of fuel. Yet the prescribing of coal is already being practiced with success by a number of consulting engineers and engineering service organizations. The proper performance of such work demands unusual training and ability, since it requires a knowledge of combustion plus familiarity with sources of fuel supply, mine prices, transportation costs, fuel storage and the factors affecting reliability of supply.

The proper fuel to use is that which can be depended upon to carry the given steam load with the least overall cost. One big factor in this cost is the cost per million B.t.u. laid down at the plant, but failure is invited by attempts to choose a fuel on this basis alone, without taking into consideration the ability of the combustion equipment to carry peak loads with the given fuel, the efficiency obtainable with the given fuel (as affected by excess air and by carbon in the ash) and the effect of fuel selection on furnace maintenance and ash-handling costs.

So it is evident that a man competent to prescribe coal must be something more than a combustion engineer and something more than a fuel expert. He must combine the abilities of both. There is a tremendous field for expansion in work of this nature.

Practical Ideas from Practical Men

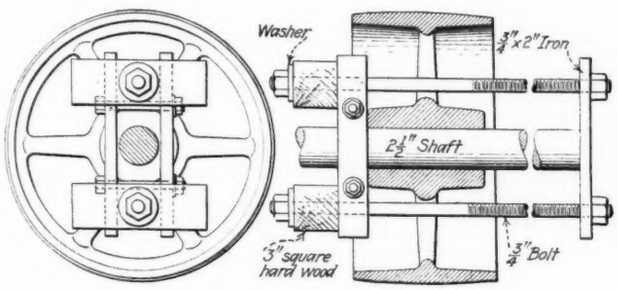


WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for June will be announced next month.

Rigging for Removing a Solid Pulley

The illustration shows the rigging we use for removing a solid pulley placed some distance from the end of the shaft.

Two ¾-in. rods of suitable length and having a long thread, are used for the drawing bolts. A short piece of ¾x2-in. iron bar is used across the end of the shaft



Method of drawing pulley off shaft

for a drawing bar, and at the other end of the bolts two sections of the same size bar are placed with one edge against the hub of the pulley (one on either side of the shaft) and held together by two bolts. Crossing these bars at right angles and carrying the ends of the bolts are two pieces of hard wood 3 in. square and 10 to 12 in. long, a large iron washer being placed between the head of the bolt and the wood block. This particular arrangement permits adjusting the bars and drawing bolts to different sizes of pulleys.

Needham Heights, Mass. G. M. PHINNEY.

The Welding and Cutting Torch in the Power Plant

When approving bills for welding repair jobs, I was usually taken aback with the cost, and I put off the fatal day for turning the bills in to the office as long as possible. It finally occurred to me that it would be more economical to have a welding outfit in the plant, so I decided the first thing to do would be to learn welding. I went to a local welder, paid him for instruction in the use of his torch, and after a short time I was doing our own welding. I have been using a torch now for about three years and have found new uses for it every day.

The large variety of work to which we have found the torch particularly adaptable includes the repairing of firing tools, building up worn parts from turbine governors, boiler-feed pumps, etc., and cutting out tubes from the boilers—work which we could not have done with a tube cutter without destroying the brickwork. In one instance the impeller on a centrifugal pump became loose on the shaft. By building up the shaft with the torch and turning it down to a driving fit in the impeller, we made a permanent repair and saved the cost of a new impeller and shaft, besides a shutdown. In addition to those mentioned, there are countless other jobs that can be done with a torch, saving considerable money and many hours of labor. In fact, I do not know of a more useful tool around a power plant. There are few plants, especially industrial or institutional, where the torch will not pay good dividends.

Training an operator is not difficult. A comparatively little study of a welding instruction book and a little practice will make a fairly good welder out of any mechanic. I do not mean that he will be an expert on preheating jobs, nor would many plants have enough work to sanction preheating equipment. He should not try any welding of pressure vessels until he has had experience under a competent welder in this work. But for all-around general repairs the torch is a time and labor saver.

Vermillion, S. C. L. A. COWLES.

Pressure Control Switch for Booster Pumps

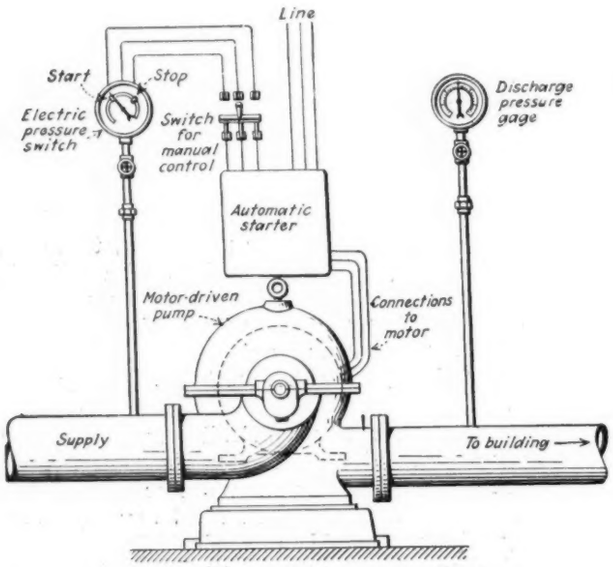
Pressure-increasing, or booster, pumps are installed in the supply lines of tall buildings or in other places where it is desired to increase the pressure existing in a water pipe. Quite often it is not necessary to have the pump run continuously, and in such cases it is preferable to have it start and stop automatically as required.

For this purpose an automatic electric pressure switch is used, where the prime mover of the pump is an electric motor. These switches consist of ordinary Bourdon pressure gages having flexible metal tubes and segmental gear, and in the face of the gage there is a slot in which there are two sliding electric contacts. These contacts are connected with the atuomatic starting switch of the motor in such a way that the motor will start when one contact is touched and stop when the other is touched.

The illustration shows the correct method of install-

ing this type of pump. The location of the pressure switch on the suction side of the pump is of the utmost importance. I have seen these switches installed on the discharge side and give good results, but I have also seen them give a lot of trouble when installed that way. This is due to the fact that when the pressure falls off and the "start" contact is made, the pump begins to turn, driving the needle over toward the "stop" contact. Owing to the impact in the discharge line it is necessary to slide this contact far enough over so as not to stop the pump at once. Frequently, this is at so high a pressure that the contact will never be made, and the pump will have to run continuously. In other words, the switch, when so installed, is only semi-automatic. It will start automatically, but has to be stopped by the operator.

However, when the switch is on the suction side as shown in the illustration, the change in pressure is in



Arrangement of booster pump control with pressure switch connected to suction side of pump

the opposite direction when the pump starts, and the needle, once having made contact, will be pressed even more firmly against the contact and with no tendency for the automatic control to oscillate. When the supply pressure becomes high enough to eliminate the pump, the needle will touch the other contact and the pump will stop.

In short, when the pressure switch is connected to the discharge line, its action may be all right in some cases and fail in others. When connected to the suction or supply line as shown, its action is positive and reliable under practically all conditions.

Pittsburgh, Pa. RUSSEL K. ANNIS.

Low- and High-Water Alarms for Steam Boilers

On account of the danger of burning the tubes or flues of a steam boiler if they are not covered by water, several devices have been developed for the purpose of giving warning before there is danger along this line. These devices operate whistles to call attention to the condition of affairs, in order that a remedy may be applied before expensive repairs are necessary or disaster follows.

The first one that I used had two connections to the boiler, one to the dome and the other to the front of the shell, just above the level of the tubes. As long as water covered the lower connection, there was no trouble, but if steam was allowed to enter it, a fusible plug made of tin and lead would melt out and admit steam from the dome.

There was no valve between this plug and the boiler, consequently when the water level was allowed to get low, it was necessary to disconnect the device and take it to a repair shop where a new plug was fitted. This alarm was used because a disastrous boiler explosion in that city had caused a law to be enacted compelling steam users to adopt them. This law was later repealed. Nevertheless, many boilers in that city are equipped with low-water alarms, but they are of the kind that blow a whistle when the water level gets low. When it is restored, the whistle is shut off automatically.

While I was fitting up a battery of three boilers, I was reminded that the insurance company that carried the insurance on these boilers did not approve of alarms that sounded for both high- and low-water conditions. The company approved the low-water alarm, but when the high was included, it was thought that confusion was liable to follow. If a whistle sounded for low water, the fireman might assume that it was blowing for high water and stop the pumps without due investigation, which of course would introduce a dangerous condition.

It is not the object of this article to decry any form of high- and low-water alarms, for the adoption of them has saved much trouble and expense. It is my object, however, to protest against the way in which they are sometimes used, as it is both dangerous and unprofitable.

It is the practice of some firemen to fill the boilers until the high-water whistle starts to blow, then to stop the pump, and wait until the low-water whistle blows before they start it again. Such a plan is condemned for the following reasons: To flood a boiler in this way puts an extra load on it for a time and then relieves it for another period. Good practice calls for a steady load at all times or at least as steady as possible. Furthermore, it is impossible to build a water alarm that will last forever and always be in good condition, consequently if absolute dependence is placed upon it, sooner or later some part of it will wear out or fail to operate, and if the fireman has become accustomed to waiting until an alarm is given before he either starts or stops his pump, he will discover that a serious mistake has been made.

Boilers should be operated as if there were no alarms on them, then if the water gets low enough to cause the low-water alarms to blow, attention will be called to this condition before the tubes or flues are burned. If it gets too high, this condition will also be noted before an engine is wrecked.

In some cases a valve has been placed between the alarm mechanism and the whistle, thus enabling the fireman to shut it off at pleasure. This is bad practice and ought to be discontinued, especially where two or three firemen are engaged in doing the work in turn. When one retires and another assumes the duties, he may suppose that the valves are open when they are not, and failure to know may result in disaster. I notice that the manufacturers of these appliances do not include valves for them. W. H. WAKEMAN.

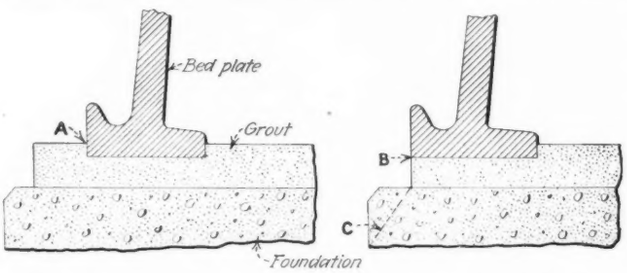
New Haven, Conn.

Comments from Readers

Protecting Foundations from Oil Penetration

I notice on page 983 of the June 23 issue a short item dealing with prevention of deterioration of concrete foundations by keeping the oil off them. This is good as far as it goes, but nearly everywhere there is a spot or two where oil accumulates in spite of precautions. We have found that the effects of oil on concrete can be minimized if certain precautions are taken when the machine is installed.

First, in grouting bedplates, the grout should not be worked around the outside of the base, as shown at *A* in the illustration, as this leaves a well in which the oil can accumulate and exert a hydrostatic pressure forcing it into the pores of the grout. Instead, it should be trimmed away flush as shown at *B*, in which case



By finishing grout flush with bedplate and beveling foundation, oil penetration is materially lessened

there is nothing to force it into the joint and the penetration will be much less rapid. If the size and position of the foundation can be measured closely enough to leave an even edge, it also helps to bevel away the corner of the foundation right up to the edge of the grout, as indicated by the line *C*, so that there will be no tendency for oil to lie on the surface of the foundation and work under the grout.

The penetration of oil can be further prevented by applying a coat of concrete floor primer and two coats of concrete floor enamel as soon as possible after the foundation is finished and the machine grouted. Most of these paints are oilproof, particularly the better ones made for engine-room floors, and they will not only protect the foundation indefinitely but will add much to the appearance and tidiness of the place, as there are no discolored spots where oil has dripped and they can be wiped up as easily and thoroughly as the machine itself.

We had a turbo-generator foundation treated in this way about four years ago, and as this is a machine where the advice to keep it oiltight, especially around the drain plug, etc., is much easier to give than to put into practice, the foundation has been more or less wet with oil continuously in that time, without any signs of deterioration of the paint or concrete.

New Haven, Conn. H. D. FISHER.

Leaky Discharge Valves and High Temperatures

With reference to the letter of Frank C. Blomberg, in the June 2 issue, commenting on my discussion of his article in the March 24 issue entitled "Will a Broken Discharge Valve in Air Compressor Cause the Temperature of the Air to Increase," fails to tell us, or even suggest any vindication of the hypothesis, how an air compressor can go on delivering approximately its full quota of compressed air while a leaky or broken discharge valve allows a portion of the air to be isolated and churned back and forth and successively recompressed, becoming continually hotter and hotter, until an incendiary temperature is produced and ignition or explosion results.

Since my first letter in the May 5 issue there has appeared in *Engineering and Mining Journal-Press* for May 9, a report of a series of air-compressor tests made at the University of California, from which report I extract the follow paragraph:

> The effect of a leaky discharge valve was determined by boring two $\frac{1}{8}$ in. holes in one of the poppet discharge valves. Fig. 5 [which it is not necessary to reproduce here] shows the result when the compressor was under load. The temperatures were normal, the conclusions reached being that, if a normal flow of air is passing through the compressor, a leak in the discharge valves does not cause an increase in the temperature. The heat does not accumulate, but is carried away by the flow of air.

Plainfield, N. J. FRANK RICHARDS.

Having read the letter by Mr. Sandstrom in the May 26 issue, it seems to me that this subject is much more complicated than Mr. Sandstrom infers. It is true, as he says, that there is a lowering of the temperature of the air due to its expansion and doing work on the piston, but if the cycle of operations is considered from the beginning of the "leaky" stroke to the end of the compression stroke, it will be seen that only a portion of the air that leaks through the valve will contribute any cooling effect; that is, that portion which leaks through during the earlier part of the stroke. At three-quarter stroke there will be little travel left in the piston to expand the air that comes in. The slow reversal of the motion of the piston allows ample time for a large quantity of air to leak back, and the temperature of this air after its eddies have subsided will be equal to that in the discharge pipe. I would refer him to Joule and Kelvin's experiments on this point. (I omit the molecular cooling effect as being negligible at these temperatures.)

Supposing that the size of the hole in the valve is such as to never allow the suction valve to open, then there will be a mixture of air expanded from the earlier part of the stroke with a much larger amount as hot as the discharge pipe which has been blowing in during the remainder of the "leaky" stroke and part of the compression stroke. It is then obvious that this

mixture will be, when the piston starts to compress it, at a higher temperature than the air that had simply been drawn through the suction valve in the ordinary way, and will therefore be discharged at a higher temperature than due to the normal discharge with a tight valve. This effect will be cumulative.

Assuming a discharge pressure of 100 lb. and a leak such that there is a mean effective pressure of 50 lb. on the leaky stroke, and considering the air that blows into the cylinder at the slow motion at the end of the stroke, it would be reasonable to assume that the full discharge pressure of 100 lb. will be obtained before the piston has completed one-third of the compression stroke. This will give an average pressure of 90 lb. during that stroke. Then if the piston has only 50 lb. m.e.p. during the outward stroke, where is the power expended if not in heating the air that surges in and out of the cylinder?

Of course, if the discharge pipe is very short then the air that leaks back will be largely taken from the receiver, which may be large enough to dissipate the additional heat by radiation so that no appreciable rise of temperature would occur.

There will be two extreme cases—one where the leak is small, when the heating effect will be negligible, and the other where the whole discharge valve is removed. In the latter case, if the valve area is large compared to the volume swept out, the m.e.p. will be equal during each stroke and consequently no work will be done to be accounted for.

Victoria, B. C., Canada. H. C. GUNSON.

How Often Should Engineers Change Shifts?

With reference to R. G. Summers' question in the May 19 issue, "How Often Should Engineers Change Shifts?" this is a problem that must be solved for each individual case. The following remarks are the result of experience in a twenty-four hour plant over a period of years.

The system of shift changing, like the eight-hour day, has now been almost universally adopted in the twenty-four hour plant. We still know of some plants that operate on twelve-hour shifts and require a man to work twenty-four hours when the shift changes, but they are few and far between and the steady shift is following in the wake of the twelve-hour day.

The principal reason for a changing shift is the fact that there is a great difference in the desirability of the different shifts during the twenty-four hours. The day is usually divided into shifts of 7 a.m. to 3 p.m., 3 p.m. to 11 p.m., and 11 p.m. to 7 a.m.; or 8 a.m. to 4 p.m., 4 p.m. to 12 p.m., and 12 p.m. to 8 a.m.

The 7 a.m. to 3 p.m., or day, shift is of course the most desirable, because it covers the day period which is the natural period in which to work. The 3 p.m. to 11 p.m., or evening, and 11 p.m. to 7 a.m., or night, shifts are less desirable, the least desirable being open to question. Some men prefer the evening shift to the night shift because a man on the evening shift can get his sleep at night, and some prefer the night shift to the evening because the evening shift precludes the opportunity of obtaining any outside diversion either in the afternoon or the evening.

Owing to the great difference in desirability of the three shifts and to the fact that the work on each is equally important, it is only fair to the men to change the tour of duty regularly. In addition to the desirability feature the change allows each man to become familiar with the operating conditions during the twenty-four hours and gives each a period of day service when his work can come directly under the attention of the chief engineer or other superior and when he has a chance for conversation with the chief, an opportunity that is usually not possible on the other shifts.

The frequency of the change of shifts will also depend on local conditions and whether a regular relief man is employed. We will first consider a twenty-four hour, seven-day plant without regular relief operators.

In this plant the only time the operator has off is when the shift changes, and this fact should influence the frequency of change. Another factor affecting the change is, that when an operator changes from the night to the day shift he must change his mode of living, sleeping at night instead of day and having his meals at different times.

As there are three operators per twenty-four hours for each position, one man has a day off every time the shift changes and it takes three changes to give every man his day off. Thus if the shift is changed weekly, each man has a day off every three weeks; if it is changed bi-weekly, he has his day off every six weeks, and if monthly, every twelve weeks. Now it is evident that one day off every twelve weeks, or four days per year, is by far too little, so the choice rests between weekly and bi-weekly shift changes.

Weekly is better for time off, but keeps a man broken up, owing to too frequent changes in eating and sleeping habits.

It has been our experience that the bi-weekly plan is most practical where no regular relief man is employed. Where regular relief is supplied, the day off feature does not enter into the consideration, and the best period of change will fall between the bi-weekly and the monthly plan.

The employment of a regular relief man is an excellent plan, as it allows much more freedom for the operators, but a satisfactory man for this position is hard to find as the position is not one that appeals to men because of the constant changing of working hours. A schedule that will give relief to all operators and at the same time keep the relief man regularly employed is hard of accomplishment in most plants.

It would be well for the chief engineer to canvass his men to get their ideas and wishes concerning the shift change, but after the results of the canvass are tabulated and the best method decided, the chief should by all means issue a notice containing a schedule that is final, as otherwise each man will want his particular plan and much ill feeling and jealousy may result, especially in a large plant. When the schedule is established, all shift men should be required to adhere to it from the turbine-room engineer to the ash handler, each man shifting in his own class.

The method of accomplishing the shift change is sometimes difficult of comprehension. The shifting is usually done over Sunday. The following schedule, which illustrates the method of change, is one that we have found most satisfactory to the greatest number of operators. It is used at bi-weekly intervals.

	7 a.m.	3 p.m.	11 p.m.	7 a.m.
Up to Saturday	A	B	C	
Sunday	A	C	A	
Monday on	B	C	A	

Under this plan operator B on the 3 to 11 shift is

off from 11 p.m. Saturday to 7 a.m. Monday. The time is made up by operator A, who works sixteen hours in two eight-hour shifts on Sunday, operator C doing his regular eight hours.

Where objection is raised to the double shift of the operator A on Sunday, another satisfactory schedule is:

	7 a.m.	3 p.m.		11 p.m.	7 a.m
Up to Saturday	A		B	C	
Sunday	A		7 p.m.	C	
Monday on	B		C	A	

Under this plan B is still off, but his time is made up equally by A and C, who both work twelve hours on Sunday.

There are other workable schedules, but the two mentioned have given the best satisfaction in our case. While the shift change is usually made on Sunday this is not necessary, any other day being equally satisfactory as far as scheduling is concerned provided the same day is adhered to regularly. F. A. SPENCER.

Woodbridge, N. J.

I, too, would like to hear more about this question. We have approximately 125 men working on three shifts of eight hours each. We have never felt that it would be a good policy to rotate the shifts every two weeks because the men would change shifts so often that they could not become acclimated to the change. The result would be loss of sleep and the men would not feel at their best physically.

Another consideration is that our day load is much heavier than the night load and duty is more strenuous. This has some bearing on the subject. Also we find that there always is a certain class of men who prefer night work, especially the shift from 10 p.m. to 6 a.m. We do not keep our men on the same shift all the time, we move them around occasionally, but with no definite schedule, and it seems to work out pretty well. Still from time to time the question comes up whether it is better to rotate shifts or not. The men as a whole seem to be satisfied with the present arrangement. We are open for suggestions on this subject and would like to learn the experiences of others, with the idea of improving this condition if it is possible.

I should like to hear from other chief engineers of industrial stations in regard to allowing the men time off and if possible to determine what arrangement seems to be favored in this respect. Our men used to work on twelve-hour shifts with two days a month off with pay. Then we changed from two twelve-hour shifts to three eight-hour shifts with no time off, seven days a week. The eight-hour shift works out very well, but the no time off feature works a hardship on the men. I should like to ask what other engineers think is the best schedule to adopt in this respect; how many days they should get off per month; whether these men should take time off on their own time, that is, without pay, or whether a compromise should be made. For instance, if they should take four days off per month, whether they should receive pay for two of the days.

South Bend, Ind. J. E. TOBEY.

I consider it a good plan to leave watch engineers on the same shift all the time, because the men get more familiar with their duties and what is expected of them on that shift, whereas by changing them around they get confused and are more likely to become dissatisfied. It has been by experience that men prefer to stay on one shift, as they do not like having their regular hours broken up by changing every two weeks. Just about the time they get accustomed to the hours of one shift, they have to change and take different times for meals and rest.

As for the change giving the chief an opportunity to observe the men, it seems to me that if he knows his job, he can tell what the men are doing by the condition of the plant. If personal instruction is needed, he can call the man to the office, and most engineers are pleased to have their chief give them information, unless he is one of the class that uses the "Big I" and "Little You." I like to hear a chief say, "We will do this or that," not "I am going to do it." I also like to have a chief ask for suggestions and compare ideas with his men, then decide which is best.

Mr. Summers asks if the chief should make the schedule for the men to work by. I do not think so. When a man is working a regular shift and is satisfied, I cannot see why the chief should make changes. I do agree with him, however, that it is a good plan to have a relief man and give each man a day a week off, and where the plant is working three eight-hour shifts, this can be done very nicely.

Taking his question as a whole, I would say when the engine- and boiler-room crews are all working to advantage and are satisfied, leave them alone.

Memphis, Tenn. CARL DEGARMO.

The Master Mechanic

I read with interest the letter in the April 7 issue by Thomas Pascoe, on "The Master Mechanic," in which he sets forth a number of facts dealing with the routine duties involved in that capacity, but I cannot agree with some of the statements in the last two paragraphs of his letter.

It is a mistake to consider the master mechanic as the only one capable of meeting all emergencies as they arise. It is his duty to see that the foreman drills each man so that he can take care of his duties without detail instruction when emergencies arise.

It is also his duty to make inspection tours of the general shop or plant and keep in close touch with the work being done. But if he should notice a man not doing the work properly during his tour of the shop he should call the foreman's attention to it, rather than speak to the man himself, because it is the foreman who is looked to for results, and by so doing better co-operation is had.

The master mechanic should not be the only recognized leader in a plant or shop, but he should so conduct himself at all times that he will be a good example to those who come in contact with him. Sunning oneself on a doorstep, as mentioned by Mr. Pascoe, or leaning against a post or machine is a poor example to set for the men under you.

When the master mechanic has a problem to figure out, it should be done in the office and not on the doorstep. The example thus shown is one of business, and not idleness. If his work is up-to-date and he has considerable time to spare, it might be well spent by visiting the manager's office and discussing some problem with him or by visiting a neighboring plant. But in any case he should always bear in mind that his actions and method of working are considered more or less as a standard by the men under him.

Galveston, Tex. H. W. ROSE.

Questions and Answers

Conducted by

Franklin Van Winkle

Arrangement of Manhole

Why are boiler manholes placed with the narrow dimension lengthwise of the shell? *A. C.*

Without considering the relief of stresses by tubes or stays, for a given internal pressure per square inch the longitudinal stress, or stress at right angles to a circumferential section of the shell, is only one-half as much per unit of length as the girthwise stress per unit of length of the shell. Hence, to weaken the shell as little as possible, manhole openings are placed with their narrow dimension lengthwise of the shell.

Adjustment of Lead of Corliss Engine

How may too early admission be remedied in a single-eccentric Corliss engine? *P. S.*

When the eccentric has been set more than 90 deg. ahead of the crank for the purpose of obtaining early release and compression by the exhaust valves, the admission valves must have lap when the wristplate is in central position, in order to delay admission until the beginning of the stroke. Lap of the steam valves is obtained by adjusting the length of the rods that connect the wristplate with the valve arms. In nearly all engines opening of the valves is accomplished by a pull on the rods, and to increase the lap and thereby reduce the lead, the rods are to be lengthened.

Ratio of Expansion

What is the ratio of expansion when the cutoff is at 27 per cent of the stroke and clearance is 6 per cent? *J. J. S.*

The real ratio of expansion is the number of times the actual volume of steam in the cylinder at the time of cutoff would be expanded to occupy the volume of piston displacement per stroke plus the clearance volume. With 6 per cent clearance volume and cutoff at 27 per cent of the stroke, the volume present at the time of cutoff would be $27 + 6 = 33$ per cent of the volume of piston displacement, and as the volume of piston displacement plus clearance volume would be $100 + 6 = 106$ per cent of piston displacement, the real ratio of expansion would be $106 \div 33 = 3.21$.

Advance of Eccentric of Single-Eccentric Corliss Engine

In a single-eccentric Corliss engine, why is it necessary to have the eccentric more than 90 deg. ahead of the crank? *R. M. A.*

The eccentric must be advanced in order to obtain compression without delaying opening of the exhaust valves. If the eccentric is in the 90-deg. position and compression is obtained by simply adjusting the exhaust valve rods, so the exhaust valves have lap when the wristplate is in the central position, the steam could not be released at exhaust until after the piston completed its stroke. As that condition is not permissible and as it is desirable to have release occur before completion of the stroke, little or no lap is to be given to the exhaust valves and compression is to be obtained by advancing the eccentric beyond its 90-deg. position, thus making both release and compression take place sooner. In consequence of advancing the eccentric, the steam valves must have lap when the wristplate is in central position, in order that they may be held closed during the period of compression and until it is desirable to have the live steam admitted.

Placing Anchor Bolts in Old Foundation

How can anchor bolts be provided for a new engine on an old foundation that requires new locations for the bolts? *E. S. B.*

Drill bolt holes in the old foundation in proper locations for the new bolts and insert new bolts with split ends to be expanded in the bottoms of the holes by driving the bolts against steel wedges that can be started before the bolts are lowered in the holes. Before the bolts are placed, they should have their sides roughened by raising rasp-like projections with a sharp cold chisel. After the lower split ends have been spread against the sides of the holes by driving the bolts against the expanding wedges, a good anchorage should be obtained by filling the holes around the bolts with a thin grouting of neat portland cement.

Packing for Gage Glass of Gasoline Tank

What kind of packing is suitable for the gage glass of a gasoline tank? Rubber packing rings and other ordinary kinds of packing have given trouble from leakage. *S. M. B.*

A good quality of rubber glass gage packing ring can be made to hold tight in gasoline for a long time if the packing ring is protected by a coating of shellac varnish which is allowed to dry before the ring is placed. The varnish coating may become cracked and the life of the ring shortened from setting down the packing nut too hard or from vibration of the glass gage fixtures. Although with ordinary care the packing may remain tight for a long time, the connections of a glass gage should not be left open constantly to indicate the level of gasoline, as the material is highly inflammable and accidental breakage of the gage glass or failure of the packing may result in serious damage from fire. When ordinary glass gage fixtures are used, the valves should be kept tightly closed except while making an observation of the gage.

Flow of Steam Into Lower Pressure

What would be the relative flow of steam at 5 lb. gage pressure when discharging through an orifice into a space where the pressure is 15 in. vacuum, as compared with discharging against 10 in. vacuum?

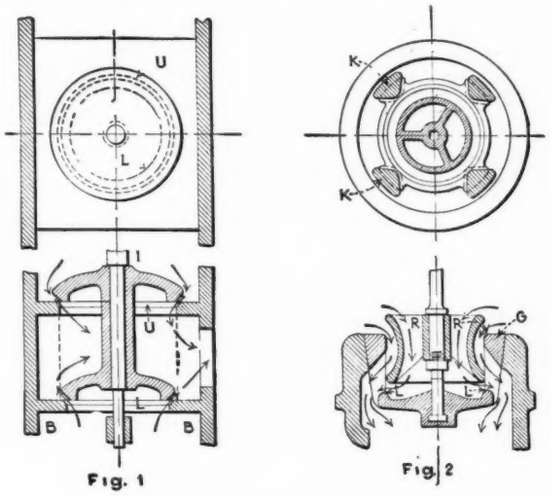
W. R. D.

The flow of steam of a greater pressure into an atmosphere of less pressure increases as the difference of pressure is increased, until the lower pressure becomes only 58 per cent of the greater absolute pressure, but the flow is neither increased nor diminished with any greater reduction of the lower pressure, even to the extent of a perfect vacuum. A pressure of 10 in. vacuum would be equal to $(30 - 10) \times 0.491 = 9.82$ lb. per sq.in. absolute, and the initial pressure of 5 lb. gage would be equal to $5 + 14.7 = 19.7$ lb. per sq.in. absolute. Hence, when discharging against 10 in. vacuum, the lower pressure would be only $(9.82 \times 100) \div 19.7 = 49.8$, or practically 50 per cent of the initial absolute pressure. The absolute pressure at 15 in. vacuum would be even lower and since, in each case, the lower pressure would be less than 58 per cent of the initial absolute pressure, the flow would be the same.

Advantages of Poppet Valves

What advantages are obtained by the use of poppet valves, and why are they not more commonly used for steam engines? *R. L. B.*

The advantages of this type of valve are that when made in the form of double-seat, or, as commonly termed, "double-beat" valves, using two disks nearly of equal size carried on a single spindle, the disks may

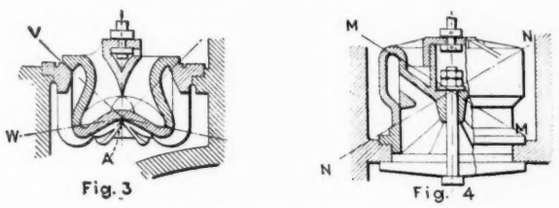


Double-beat poppet valves

be nearly balanced by the steam pressure and may be operated to obtain quick and large opening and quick closing.

Figs. 1 and 2 illustrate two principal forms of double-beat poppet valves which are shown open for flow of steam in the direction indicated by the arrows. In the simple form illustrated in Fig. 1, the steam supply is at *I* and *B* on opposite ends of the valve and the flow controlled by the valve is downward toward the upper seat *U* and upward toward the lower seat *L*; while in the type shown in Fig. 2, the flow toward the lower seat *L* is received axially through the valve in the direction indicated by the arrows *RR* and thence is discharged radially. In each of these the inside diameter of the upper seat is enough larger than the lower one to permit admission of the lower disk through the upper valve seat when the parts are assembled. The unbalanced effect due to the difference of diameters sometimes is obtained by making the upper and lower disks of the same diameter and providing a ring seat for the upper disk to fill the opening required for the admission of the lower disk. In the valve shown Fig. 2 the seats are in the form of an open cage *G* suspended by hangers *KK* shown in the plan view.

The disadvantages of double-seat valves are the cost of construction and leakage from dirt in the steam and



Forms of poppet valves for compensation of warping and unequal expansion

from unequal expansion or warping of the disks and seats. The effects of distortion are largely overcome by having the valves short and by grinding them to their seats while under the temperature of steam at which they are to be used, and also by providing seat surfaces of conical form with a common apex in the valve center line. Fig. 3 shows a sectional view of a double-beat valve where the surfaces of the seats are different conical surfaces with sides *V* and *W*, the apexes of the cones meeting at *A* in the valve center line. Another form is shown in part section, Fig. 4, where the separate conical seating surfaces are on continuous lines *MM* and *NN* which intersect in the valve center line.

Air in Suction Water

How does air contained in water affect the operation of a pump? *W. A. C.*

Under ordinary atmospheric pressure water contains about 2 per cent of air in solution, and when the pressure on the surface of the suction water is diminished, this air expands. With a suction lift of 22 ft. the absolute pressure above the water would be equal to a head of $34 - 22 = 12$ ft. of water, so that the air present, if given sufficient time to be liberated, would expand $\frac{34}{12} \times 2 = 5.6$ per cent. The air then would occupy 5.6 per cent of the water cylinder with corresponding reduction in water capacity. However, this condition is not usually attained in practice, because with an ordinary length of suction pipe the water is not in the pipe for a long enough time for the air to become liberated. The actual effect cannot be computed, because the amount of air actually liberated in a given time cannot be calculated.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication, and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

The Capacity of Tanks

THERE are no computations more commonly made in power-plant work than those involving the capacity of tanks. While the straight cylindrical tank, either horizontal or vertical, is of most frequent occurrence, rectangular tanks are common, as are slightly tapered wood-stave water tanks.

In measuring such tanks it is sometimes convenient to deal in feet and fractions and sometimes in inches, depending ordinarily on the size of the tank. Whichever unit of measurement is used, the results may be desired in gallons, cubic feet, pounds of water or occasionally in cubic inches.

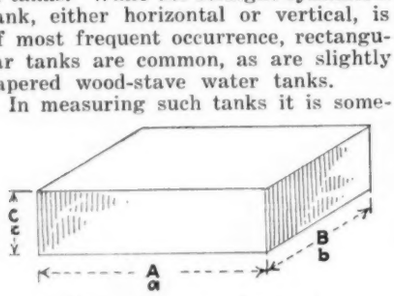


Fig. 1—Rectangular tank

(Here and throughout article, capital letters are used for feet and lower-case letters for inches.)

Cu.in. $= a\ b\ c$
Cu.ft. $= A\ B\ C$
U. S. gal. $= 0.00433\ abc = 7.48\ ABC$
Lb. water at 62 deg. F. $= 0.036\ abc = 62.4\ ABC$

To save the time of the busy engineer in looking up formulas, going through a number of multiplications and divisions, etc., this article brings together simplified formulas for the capacities of the forms of tanks most commonly encountered by the operating engineer. In all formulas and diagrams capital letters are used for dimensions in feet and lower-case letters for dimensions in inches.

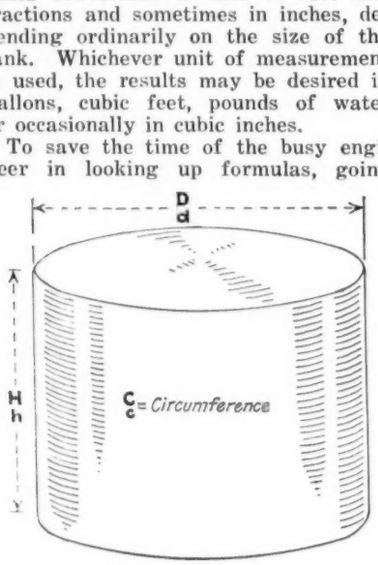


Fig. 2—Cylindrical tank

Cu.in. $= 0.785\ hd^2 = 0.0795\ hc^2$
Cu.ft. $= 0.785\ HD^2 = 0.0795\ HC^2$
U. S. gal. $= 0.0034\ hd^2 = 5.87\ HD^2 = 0.000345\ hc^2 = 0.595\ HC^2$
Lb. water at 62 deg. F $= 0.0284\ hd^2 = 49\ HD^2 = 0.00288\ hc^2 = 4.96\ HC^2$

Formulas have been provided giving the results in cubic inches, cubic feet, U. S. gallons and pounds of water at 62 deg. F. Provision has also been made for the direct use of measurements without transforming them, whether they be in feet or inches, as long as the two units are not mixed.

Finally, account has been taken of the fact that it is sometimes more convenient, in the case of cylindrical tanks, to measure the circumference by means of a tape than to measure the diameter directly. Formulas are given, making it unnecessary to measure or compute the diameter in such cases.

The exact formulas of Fig. 3 cover tapered or conical tanks of any proportions. For the great majority of practical cases, however, the method of Fig. 4 will be accurate enough. In most wood-stave tanks, for example, the taper is so slight that capacities figured from the diameter or circumference at the center will be very close to the exact values figured by the formulas of Fig. 3. This will be found to be a great convenience, as it is easy to stretch a tape around such tanks at the center.

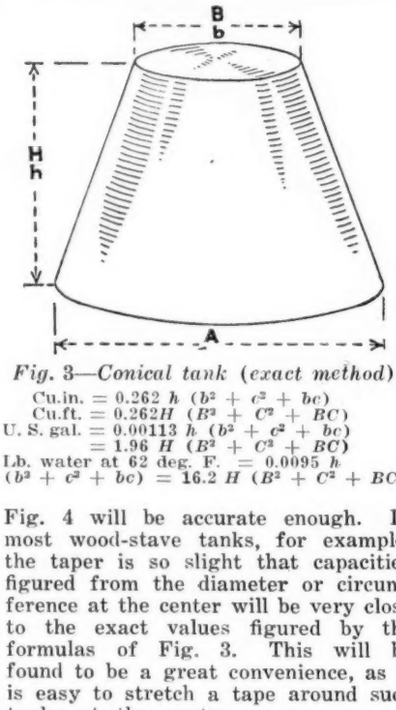


Fig. 3—Conical tank (exact method)

Cu.in. $= 0.262\ h\ (b^2 + c^2 + bc)$
Cu.ft. $= 0.262H\ (B^2 + C^2 + BC)$
U. S. gal. $= 0.00113\ h\ (b^2 + c^2 + bc) = 1.96\ H\ (B^2 + C^2 + BC)$
Lb. water at 62 deg. F. $= 0.0095\ h\ (b^2 + c^2 + bc) = 16.2\ H\ (B^2 + C^2 + BC)$

Where the tanks of Figs. 1, 2, 3 and 4 are partly full, the actual depth of liquid must be used in figuring the contents. In Fig. 3 B must be measured at the liquid surface, and in Fig. 4 D and C must be measured half way between the liquid surface and the bottom of the tank.

Where the outside circumference of a tank is measured and it is desired to make a correction for the thickness of the walls, subtract six times the wall thickness (6.28 times to be precise) from the measured circumference to get the net circumference.

This follows from the fact that each inch of thickness changes the radius by 1 in. and the diameter by 2 in. Since the circumference is equal to the diameter multiplied by 3.14, each inch of thickness must increase the circumference $2 \times 3.14 = 6.28$ in.

An old problem, but one that causes trouble at times, is that of the contents of a horizontal cylindrical tank, partly full. The table under Fig. 5 enables such problems to be handled.

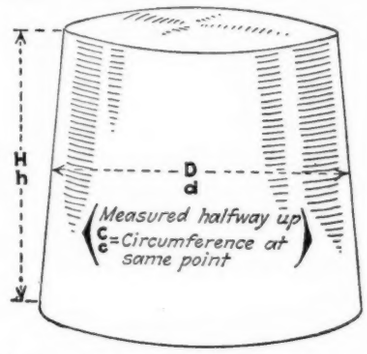


Fig. 4—Conical tank with slight taper

Where a conical tank has a total taper that is small compared with the top diameter, as is the case with most wood-stave water tanks, the capacity can be figured closely enough from the formulas of Fig. 2 for a cylindrical tank, using the diameter or circumference at the middle section of the tank.

One problem not covered in the figures is that of bumped heads, such as are commonly used on horizontal cylindrical tanks. In such cases it may be assumed without great error that the length of an equivalent flat-headed tank is equal to the length of the straight portion plus half the depth of each bumped head.

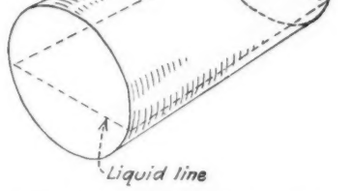


Fig. 5—Horizontal cylindrical tank, partly filled

Figure volume of full tank (Fig. 2); find percentage of total depth that is filled and refer to following table for percentage of total capacity that is filled.

Per Cent Full			
By Depth	By Volume	By Depth	By Volume
0	0		
5	1.87	55	56.36
10	5.20	60	62.65
15	9.41	65	68.81
20	14.24	70	74.77
25	19.55	75	80.45
30	25.23	80	85.76
35	31.19	85	90.59
40	37.35	90	94.80
45	43.64	95	98.13
50	50.00	100	100

New and Improved Equipment

Kennedy Unit Coal Pulverizer

The Kennedy-Van Saun Manufacturing & Engineering Corp. has recently added to its line of equipment the air-swept ball and tube coal pulverizer shown in the illustration.

Although similar in many respects to the larger mill made for some years by this company for industrial uses, a number of changes have been made with a view to increasing the reliability and reducing the power consumption.

Referring to the illustration, the mill consists essentially of a rotating cylinder in which steel balls reduce the coal to necessary fineness, a disk feeder and an independently driven exhauster for removing the finished product from the mill and delivering it to the boiler furnace together with the required amount of air for combustion. The coal previously crushed to 1¼ in. or less passes by gravity from the hopper *A* on to the slowly moving disk *B* from which it is discharged to the mill by an adjustable unloading arm or plow. By moving the arm from the periphery toward the center of the disk, the amount of coal fed to the mill is increased, or by moving it outward the reverse takes place. The disk is driven at constant speed through a worm-gear unit.

The cylinder, which is driven by a constant-speed motor through a straight spur-gear reduction, is carried on two hollow trunnions *C* through which the coal enters and leaves the mill. The interior of the cylinder is lined with special sectional steel liners held in place with key sections, and the exterior is fitted with a silencing jacket.

The balls that constitute the grinding media are of Herculite steel and occupy about 35 per cent of the mill volume. In operation the impact action of the balls as the mill rotates reduces the coal to the required fineness and it is then removed from the mill by a current of air induced by the exhauster *D*.

The degree of fineness of the coal is controlled by regulating the speed of the exhauster, which is driven by a variable-speed motor and by adjustment of the air inlet port.

Features of the pulverizer are the simple feeding mechanism and slow speed of the grinding drum which tends to reduce the maintenance charges. The pulverizers are made in capacities varying from 250 to 30,000 lb. of coal per hour.

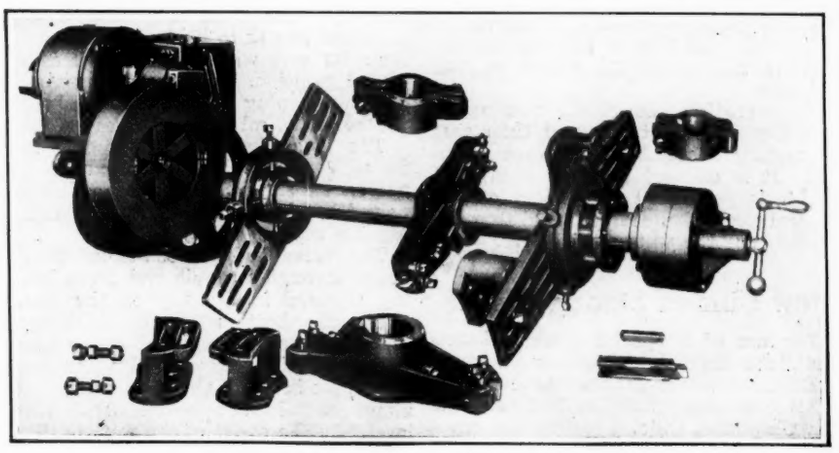
Rooksby Motor-Driven Boring Bar

E. J. Rooksby & Co., Philadelphia, Pa., have recently added to their line of portable boring machines the motor-driven boring bar shown in the illustration.

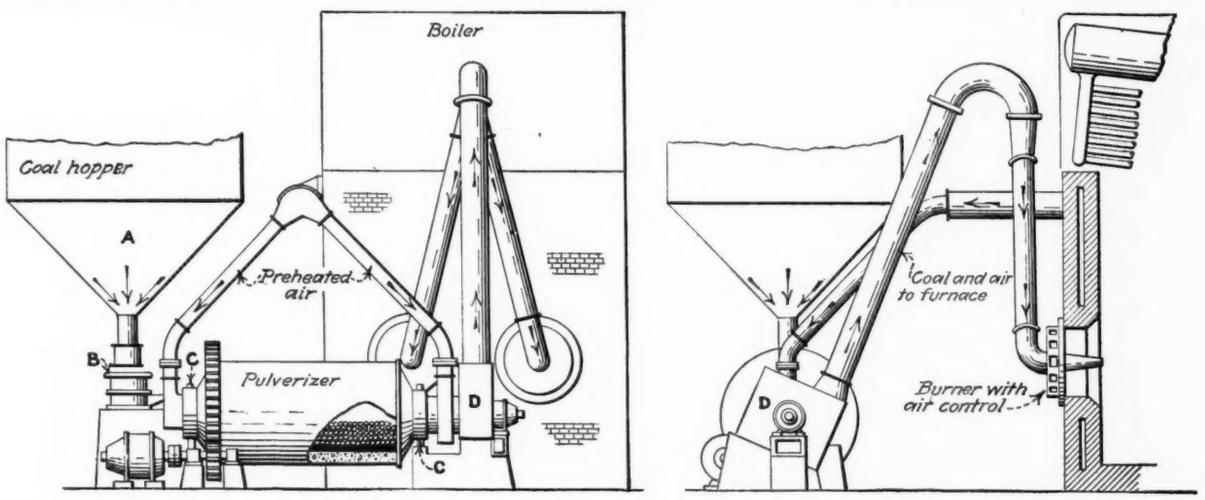
The motor is mounted on the gear drive frame, and the speed reduction is accomplished by shifting gears giving four or more changes of cutting speeds—suitable for all cylinder diameters within the range of the bar.

The machines are furnished with either direct- or alternating-current constant-speed motor or with a variable-speed motor if desired, in which case the speed gear box is not required. Double-arm cutter heads are provided to permit using a cutter on directly opposite sides of the bar. The cutter heads are fed along the bar by an inclosed feed box as shown at the outer end of the bar.

The machines are made in several sizes with bars from 3 to 6 in. in diameter and designed to bore valve chambers, bushings or cylinders ranging from 7 to 48 in. in diameter.



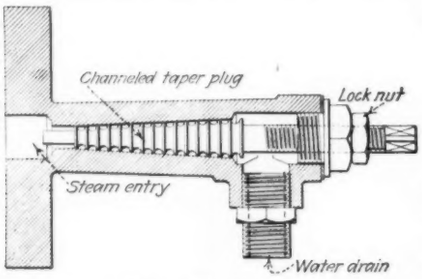
Partial assembly and parts of the motor-driven bar



General arrangement of unit pulverizer installation

French Steam Trap

A simple steam trap has been developed in France and is being introduced into England according to the Engineer, London. As shown in the illustration, the trap consists of a hollow thimble into which is placed a



Taper Plug Trap

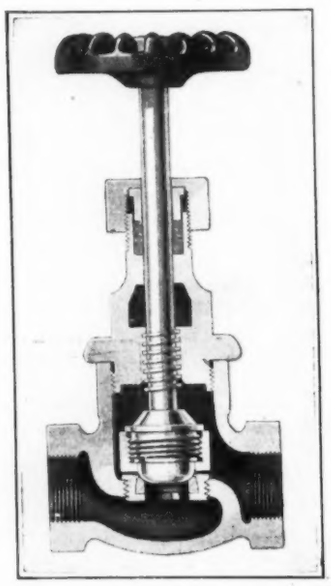
tapered plug containing a series of channels. The plug is so inserted that it does not touch the sleeve at any point.

In operation the steam and water flow from channel to channel, the steam expanding successively in each channel. It is claimed that the escape of steam is prevented by reason of the several expansion channels and that the draining of the water is positive.

New Line of Strong Valves

The use of a special metal, "Anum Metl," for the disk and seat is a feature of a line of valves brought out recently by the Strong, Carlisle & Hammond Co., Cleveland, Ohio.

The disk is attached to an enlarged



Section of valve showing detail of disk and seat

end of the stem by a clamping nut as shown, and the seat of special metal is inserted in a threaded ring which is screwed into the web in the body. One of the claims made for this valve by the manufacturer is that there is sufficient metal in the disk and seat for regrinding to last the life of the body and yoke. The yoke is provided with a radiating or cooling chamber directly above the threads.

This line of valves is built for saturated steam pressures up to 300 lb. and 500 deg. temperature or 2,000 lb. hydraulic. For ammonia or acid solutions and temperatures about 550 deg. or for higher pressures, the valves are furnished with special metal bodies, yokes and stems.

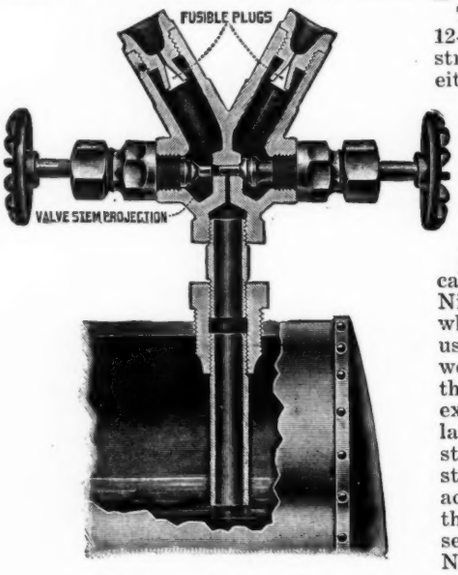
Duplex Fusible Plug

With a view to providing a fusible plug that can be readily renewed without shutting down the boiler, the plug shown in the illustration has been developed.

The device consists essentially of a special valve body equipped with two valves and two fusible plugs, the valves being so designed that one only can be closed at a time. This is accomplished by a projection on the valve disk of sufficient length to hold one valve away from its seat while the other is in the closed position. This arrangement insures one plug being connected with the boiler at all times.

The plugs are inserted in caps held in a V-shaped projection above the valves as shown, and are readily renewed by closing the valve and removing the cap.

The valve body is connected to the boiler through a nipple and brass bushing screwed in the top of the drum. From the bottom of the bushing a nipple extends through the steam space to a point below the normal water level, the nipple being of the proper length to allow the lowest permissible water level. In the event of the water falling below the bottom of the nipple, steam



Section of duplex plug

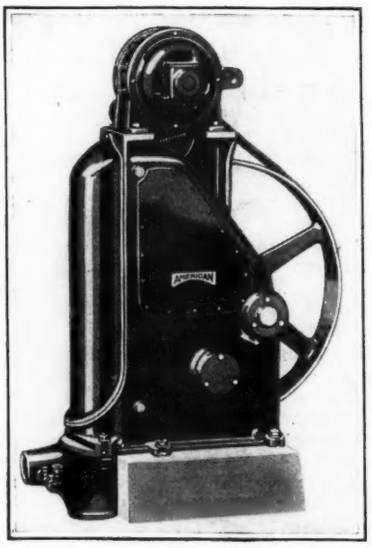
enters the pipe and causes the plug to fuse.

Provision has been made in the design of the valve body to prevent the molten metal coming into contact with the threaded portion of the valve stem. Grooves in the body direct the metal to a basin below the valve.

The plug is distributed by H. C. Hackman, 459 Murray Ave., Milwaukee, Wis.

American Deep-Well Power Heads

The American Well Works, Aurora, Ill., has brought out a new line of deep-well power heads in which all gears and driving mechanism with the exception of the driving pulley are totally inclosed. The main bearings and gears



Totally inclosed power head

run in a bath of oil, which tends to make the operation of the head practically noiseless. The gears and pinions are machine cut, and the pinions are integral with the shafts. The crank is of solid one-piece construction.

The heads are made for both 6- and 12-in. strokes for operation with single-stroke cylinders and are furnished for either electric motor or with tight and loose pulleys for gasoline-engine drive. For use with tanks they are equipped with automatic starting and stopping devices. Frostproof attachments are furnished for outdoor installations.

Engineers running a line of power cables from the Canadian side of Niagara Falls to Buffalo were halted when they found that the steel towers used to carry the wires over the stream were already loaded to capacity. Then they discovered an unused 4-in. gas main extending to the American side. A large sewer rat was captured, a stout string tied about its body and it was started through the pipe. Halfway across it refused to go farther. One of the engineers then conceived the idea of sending a weasel in pursuit of the rat. Not many seconds later the rat popped out on the American side. Heavier cord was pulled into the conduit and then the power cables were dragged through.—*Engineering News-Record.*

A thousand tractors are being built in Russia this year, and the output of agricultural machinery has doubled in the last twelve months, according to the report of F. E. Djerzinsky, chairman of the Supreme Economic Council, to the recent Federal Congress of Soviets in Moscow.

Turbine Blade Corrosion Prevented by Eliminating Oxygen*

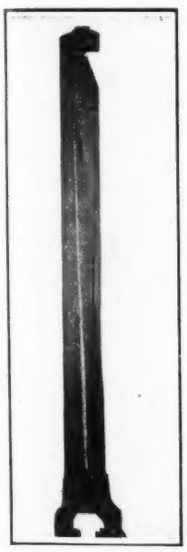


Fig. 1—Water stream erodes blade

WHILE it is often considered that the erosion of metals in contact with moving water is due entirely to a mechanical effect of the water, it appears in reality that the removal of the metal is preceded by chemical corrosion.

In the higher temperature and pressure stages of the steam turbine the buckets are submitted to the action of dry and superheated steam and wetted seldom or only by accident. Here the red and black oxides of iron form slowly and remain as a fairly good protecting coat to the iron in the high-pressure stages of the turbine.

Corrosion of steel turbine blades is example, it may begin on the 11th-stage buckets of a 23-stage turbine.

The corrosion exhibits pits and stream lines, showing plainly that the friction of the water that has condensed from the steam at that part of the turbine is responsible in part, at least, for the location and direction of the erosive action. In this region the temperature is not far from the boiling point.

Near the exhaust end the temperature reaches more nearly that of the room. While the last few rows of turbine blades are seldom corroded at all, they are usually deeply worn if water is allowed to pass along the turbine-shell walls and drop on the buckets, as it sometimes does, in a spray or small stream near the tips.

It is customary to drain the water from the turbine as near the points of condensation as possible for this reason. Fig. 1 indicates the erosion at the tip of a turbine bucket produced by a falling stream of water on the 23d row. The corrosion at *A*, Fig. 3, is part of the same bucket at 20 diameters magnification.

The corrosion at *B* also is typical of turbine buckets in the 11th stage of the machine.

In order to simulate in the laboratory the washing action of the water, a piece of machine steel about 4 in. square and approximately ¼ in. thick was mounted on a high-speed shaft arranged to operate in a bath of water. It could be viewed through a transparent front of celluloid in the water container.

In the bottom of the box sufficient water was placed so that during the high speed of rotation the tips of the metal splashed through the water at a depth of about ¼ in. The water was forced so much to the near-by walls of the containing box that there was no great regularity in the amount or frequency of water impacts.

After a few hours of splashing peculiar fine holes or pits first appeared on the rectangular points of the rotating member. These were photographed from time to time, and it was found that they increased in size as shown at *C*, *D* and *E*, Fig. 3, where the magnification is 35 diameters.

It was thought at the beginning that these pits were due to local oxidation and that when the oxide was removed by the mechanical eroding effect of the water, it quickly formed afresh. On the contrary in this experiment it appeared that the mechanical effect of the water would keep cleaning the oxide off so that the roughened fresh surface might accentuate the action. A hole, once started, ordinarily showed more active erosion than other parts of the surface.

An unexpected result was found when trying to start such a hole by first forming a rust spot on the metal and drying the surface and using it in the splashing apparatus.

The rust spot is illustrated at *G* in Fig. 2. Other spots seemed to form without regard to the previous position of the large rust spot that was first made. In fact, the spot that was at first covered by the rust seemed brighter than the rest of the sample after 17 hours' rotation.

It must be remembered, however, that the spot in the first place was allowed to dry on the disk, while it appeared that pits or points of attack had not dried or completed some other change before being washed off.

Comparison between the pits of this sample, as shown at *F*, Fig. 2, and all other samples cannot be quantitatively made, as speed and water level in several experiments varied greatly.

It appeared that the mechanical erosive effect of water containing air was capable of producing apparently the same kind of erosion on samples as had been observed on turbine buckets. It appears that the combination of chemical attack and mechanical erosion should account for erosion effects over wide ranges of velocity.

In fact, in all cases where chemical action can produce a compound that is

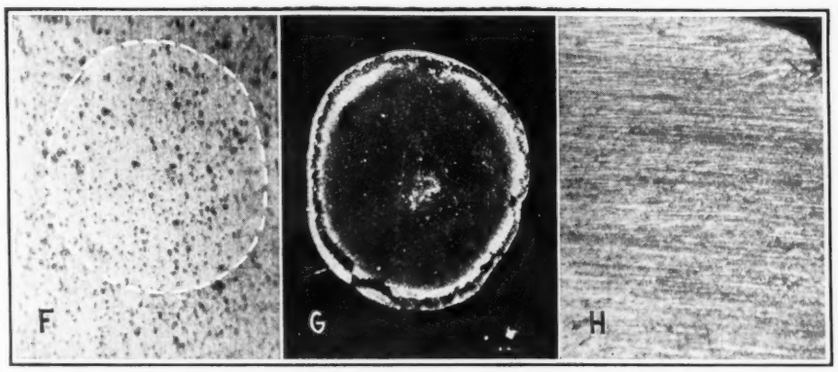


Fig. 2—Original rust spot at G *corrodes like remaining surface as at* F, *being located by dotted line. Lack of oxygen prevents wear as at* H

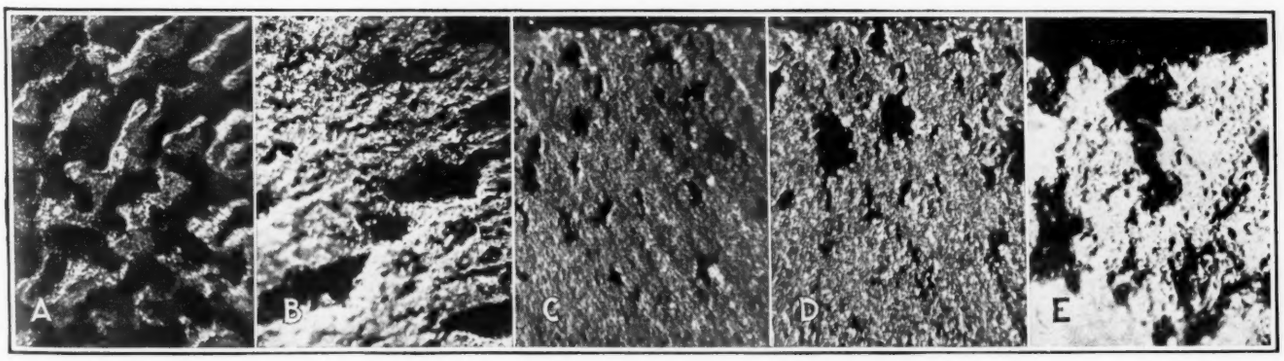


Fig. 3—Typical bucket corrosion shown at A *and* B; *pitting of experimental disk progresses as at* C, D *and* E

marked principally somewhere near the middle portion of the machine. For

*Abstract of a paper by W. R. Whitney, on "Corrosion of Iron," presented before the Division of Industrial and Engineering Chemistry at the 69th Meeting of the American Chemical Society, Baltimore, Md., April 6 to 11, 1925.

less hard, less fixed or less resistant than the metal itself, there seems to be no escape from the conclusion that it will be produced, and the mechanical reaction will account for the subsequent erosion.

In order to test the action of water without oxygen, a disk was run continuously in the splashing apparatus wherein hydrogen had replaced the atmosphere of air previously used.

It was found that with any velocity reached there was no evidence of corrosive action of the water on the metal when oxygen was excluded. This is illustrated in *H*, Fig. 2, showing the sample operated 24 hours in water with a hydrogen atmosphere. The metal remained unaffected, bright and clean as when first inserted.

Returning Exhaust Steam to the Boiler

IN THE *Engineer*, May 29, 1925, C. O. Towler advances a new method of returning the exhaust fluid to the boiler without resorting to a condenser. He states that several attempts have been made, mainly in the remote past, to effect a saving in fuel in steam-power plants by some such process. It would be superfluous to discuss the reason for their failures, as in the majority of cases the exhaust steam was intended to be returned by means of either a pump or an injector, the injector being supplied by live steam from the boiler itself or from a supplementary boiler.

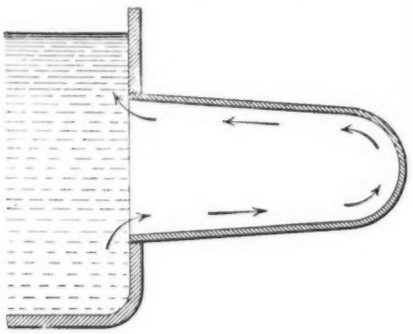


Fig. 1—Action in a closed tube

If a low-pressure fluid is to be admitted freely into a high-pressure system, there must exist in that high-pressure system a portion constantly maintained at a pressure below that of the low-pressure fluid. Such conditions are attained in practice by means of the Venturi tube in which the pressure energy of a fluid is partly converted into kinetic energy with a consequent drop in pressure.

It was stated that this system was successfully applied to an experimental steam boiler, and a portion of the boiler was maintained at a pressure lower than that at which steam was generated. These results were obtained by using short tubes closed at one end in place of the usual boiler tubes open at each end.

Using a short glass closed-ended tube, it has been observed that until the boiling point is reached, a circulation is maintained, water flowing in at the bottom and out along the top of the tube, as indicated by the arrows in Fig. 1. As soon as the boiling point is reached, however, bubbles of steam begin to form along the bottom of the tube. These bubbles steadily grow until practically the whole of the tube is filled with steam; then the water in the container forces out the steam, the tube becoming again filled with water, and the operation is repeated. Under more intense heat the rapidity of the operation increases, and eventually takes the form of vigorous pulsations, the water flowing in and the steam flowing out.

By restricting the orifice of the tube and thus giving the water and steam a greater velocity at this part, a section of the tube is maintained at a pressure lower than that at which steam is generated. The apparatus used to verify the foregoing supposition is illustrated in Fig. 2. While the pressure in the boiler was 40 lb. per sq.in. that at the restricted portion of the tube was 25 lb. per sq.in., giving a pressure difference of 15 lb. As the flow in the tube reverses twice per pulsation, the velocity of water and steam is not constant, and the pressure difference must be a mean value, although no fluctuation on the gage was discernable.

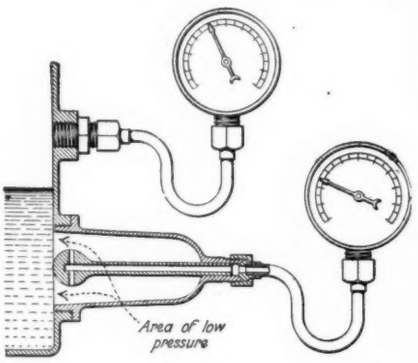


Fig. 2—Venturi effect of tube throat

In applying the principle to return exhaust steam to the boiler, if all the exhaust steam is to be returned, in order to maintain the pressure in the boiler constant, a tube must be designed so that the amount of heat taken in per unit time by the tube is equal to the difference between the total heat of the quantity of steam taken in during the same period at the pressure of the boiler and the total heat of the same steam before entering. This neglects radiation losses and assumes that all the heat taken in by the boiler is absorbed through the tubes.

To raise the pressure of steam to a degree sufficient for the efficient working of a power plant would require either a series of separate boilers or a composite boiler consisting of a number of independent sections, each section forming within itself a boiler, exhaust steam being led to the first, and each subsequent section or boiler being fed by steam from the preceding boiler. In all probability in such a composite boiler the sections in closest proximity to the furnace where the temperature is highest would be capable of producing a pressure difference of from 40 lb to 50 lb. per square inch.

A diagrammatic view of such a vertical composite boiler is given in Fig. 3. The furnace is not indicated, but is intended to be at the bottom, the products of combustion passing up the center of the boiler. Each section is divided into two chambers, an outer or main chamber, containing water and steam under pressure, and a feed reservoir. The closed-ended tubes are secured to the walls inclosing the feed reservoir, the closed ends projecting into the flue passage and the open ends communicating with the main chamber. Exhaust steam is fed into the receiving chamber *A* at the top of the boiler and passes through holes into the feed reservoir *C* of the first section. Communication between the feed reservoir and the closed ended tubes is through holes in the tubes at the section of low pressure, through which the exhaust steam flows and mingles with the contents of the main chamber at higher pressure. Steam is conducted away from the main chamber by means of an anti-priming pipe *D*, and led to a chamber between the first and second sections, and from there through holes to the feed reservoir of the second section.

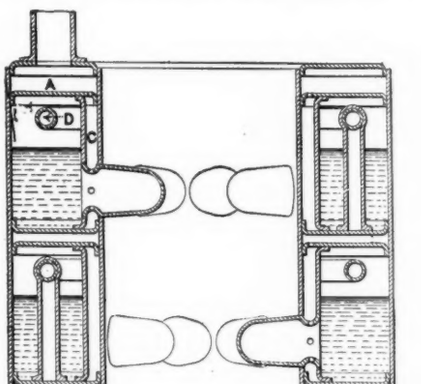


Fig. 3—Regenerative boiler

Should it be found impossible to return the whole of the exhaust steam to the boiler, the water level in the first section must be maintained by means of a pump or injector, or if the exhaust pressure is so low that the pressure in the main chamber of the first section is equal to that of the atmosphere, then the water level may be maintained by direct connection with an external tank, the level of which is kept constant by means of, say, a ball float valve. Each succeeding section would take its feed from the preceding section.

Steam regeneration on the principle roughly outlined is claimed to be a practical proposition and would result in a considerable saving of fuel, thus forming a big step toward cheap power with its consequent beneficial effect toward industry.

Petroleum Institute's Report To Be Out Aug. 7

The American Petroleum Institute's Committee of Eleven has completed its report on the "National Oil Supply," as announced in *Power*, July 7, page 37. The report will be published Aug. 7, 1925, by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City.

This report is a country-wide survey of the conditions in the oil-producing regions of the nation. It presents: Estimates of the volume of oil which may be expected from existing fields; indications as to probable discoveries of new fields; methods of possible recovery of liquid fuels from the country's vast deposits of oil shale, coal and lignites; calculations on the future population and industrial growth of the country; the probable increase in the number of automobiles and oil-consuming engines; discussions of mechanical changes which will conserve oil through more efficient utilization. The report considers the demand for a period of fifty years from now and is based on the best information available within and without the industry.

Conowingo Dam Meets Another Objection

Restraint of the Susquehanna Power Co., promoter of the Conowingo power development, from building a dam of 100 ft. crest, or any dam which will interfere with the Pennsylvania Water & Power Company's dam at Cully Falls, is asked in a bill filed in the United States Court July 13 by the latter company.

The company maintains that the development of this hydro-electric power plant on the Susquehanna River, for which the Susquehanna Power Co. is to be the operating concern in Maryland, would interfere with the water flowing over the dam and through the tailrace of the Pennsylvania Water & Power Co.

The Susquehanna Power Co. plans to sell power from the Conowingo development in Pennsylvania. It is to be associated with the Philadelphia Electric Co., and it is generally believed that much of the power will be used to electrify lines of the Pennsylvania Railroad between Washington and New York.

The hearing on the Philadelphia Electric Company's proposal to build a dam and hydro-electric plant on the Susquehanna River at Conowingo was resumed on July 14 before the Public Service Commission in City Hall. The Public Service Commission of Maryland and a representative of the Federal Power Commission attended the hearing.

The Philadelphia Rapid Transit Co., largest single user of the electric company's current, has entered a protest against the project, contending that it will not be feasible either from the standpoint of engineering or financing.

Henry M. Brinkerhoff, engineer and power expert for the Philadelphia Transit Co., testified on July 15, that the Philadelphia Electric Co. would suffer an annual loss of $1,113,360 through its contemplated operation of the combined hydro and steam plants along the Susquehanna. This figure was in contradiction to the $1,624,350 estimated annual saving offered by experts of the Philadelphia Electric Co., according to press reports.

Technical Papers Program of N.A.S.E. Arranged

The tentative technical papers program of the N.A.S.E. convention, which is to be held in St. Paul, Aug. 31 to Sept. 4 has been arranged.

Tuesday afternoon—"The Evolution of the Synchronous Machine from the Earliest to the Present Time, Flywheel Type Synchronous Motors, A Review, A Prediction," by Theodore Thou, chief engineer Ideal Electric & Mfg. Co., Mansfield, Ohio.

Tuesday evening—Motion pictures of the electrical industry. Pictures of "A Trip Through the Westinghouse Works," "An Electrical Travelogue," "White Coal," with E. H. Sniffen, power sales department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., as speaker.

Wednesday morning—"Centralized Combustion Control by Mechanical Means—Methods of Handling Large Unit Boilers at Highest Ratings Obtainable at Highest Possible Efficiency," by Joseph F. Snadgen, Smoot Engineering Corporation.

Thursday morning—"Power Factor—Low Power Factor, How Corrected—Applications of Motor Generator Sets and Voltage Control of Machines Through Them," by a speaker from the Electric Machinery & Manufacturing Co., Minneapolis, Minn.

Thursday Afternoon—Welfare paper.

Hydro-Electric Plant for Lhasa

Electricity will soon illuminate the ancient temples of the sacred and forbidden city of Lhasa, where prayer wheels have rustled and beads have clinked for centuries, regardless of events in the outside world.

Ancient rules will not be violated, however, in the installation of the equipment, it is stated. All the work will be done by Tibetans, and the temple of the Great Lama will be wired by inhabitants of the Lamasary, or monastery.

A modern hydro-electric plant is to be installed in Lhasa, and the equipment is on its way there. The final step of the journey is by mule train.

Cheap Electricity Planned for Great Britain

According to recent announcement in the press, the national scheme for giving Great Britain cheap electricity has now definitely materialized. The committee of experts appointed last year has completed its report, which is being considered by the Cabinet.

Stanley Baldwin, the Premier, in a speech at Oxford recently said that if the scheme is indorsed the first and most important task that the House of Commons would face this autumn would be the carrying out of the plans.

The scheme, which is to be administered by the electricity commissioners, provides for covering the country with a network of transmission lines centering in superpower stations in each area. The existing electric companies are to be brought compulsorily into the arrangement, it is reported.

Maine Tide Power Project Goes To Vote of People

Development of from 500,000 to 800,000 hp. by harnessing the tides is contemplated by Dexter P. Cooper, a New York engineer, with construction cost probably $100,000,000.

A charter has been approved by the Legislature of this State and New Brunswick authorities whereby interior waters of Passamaquoddy Bay will be held in check by monster dams, sections being erected in water 175 feet deep. There is a rise of tide of twenty-two feet and the power station will utilize the water on both flood and ebb tides.

In the charter is a provision for submitting it to a vote of the people to ratify or reject.

Vote will be cast in September at a special election.

Eastport and Lubec are on the coast on the American side and Campobello Island is nearby.

Preliminary work is being done now, but 5,000 men will be employed four years. It is expected that surplus power not required by Maine consumers will be transmitted elsewhere. At first local power companies opposed the project, but they have been won over by the argument that the Quoddy plant will manufacture power cheaper than they can, so they will buy whatever they need from Mr. Cooper, according to press reports.

Two immense reservoirs of sea water will be constructed, one filled constantly, and roadways will be built on top of the dams for convenience of the public in Maine and New Brunswick.

New England States Association, N.A.S.E.

The annual convention of the New England States Association of the National Association of Stationary Engineers was called to order on Thursday evening, July 9, at Mechanics Hall, Worcester, by Thomas H. Clark, chairman of the local committee and welcomed to the city by Hon. Michael J. O'Hara, the mayor.

Responses were made by Daniel L. Smith, president of the New England States Association and Theodore N. Kelsey, past president of the National Association. Welcome was further extended in an address by Roscoe H. Goddard, secretary of the Worcester Chamber of Commerce, to which National President Dudley G. Kimball responded. An address by vice-president Frank E. Gurth completed the opening exercises.

On Friday morning the convention listened to addresses by Dr. Ralph Earle, the recently appointed president of the Worcester Polytechnic Institute, on "Engineering in the Navy," T. F. Joyce, assistant to the president of the Boston and Maine, James Sumner and Edwin Perry, past president of the New England States Association.

In the afternoon, President Daniel L. Smith presented his address to the convention, Past National President William J. Reynolds and Past President of the A.S.M.E., Fred R. Low, spoke briefly, and numerous committee and official reports were discussed and disposed of.

The following officers were elected by the convention and impressively installed by National President, Dudley G. Kimball: Frank Gurth, president; Thomas H. Clark, vice-president; Walter Damon, treasurer; F. L. Tyler, secretary; Warren Brown, conductor; Edgar J. Davis, doorkeeper.

Resolutions of thanks were passed: To the local committee; his honor, the mayor; the Chamber of Commerce; Dr. Earle; Dr. Ira N. Hollis, Dr. Earle's predecessor, whose friendship for the N.A.S.E. has been manifested in many ways; and to all who had a part in making the convention successful. Resolutions were passed of regret and condolence on the passing away of Judson Pratt, chairman for many years of the Life and Accident Department.

Retiring President Smith was presented with a State President's Jewel and at the entertainment Friday evening with a silver service.

New Bedford will be the place of meeting next year, which will be held during the third week in June.

Standing, left to right—Frank E. Gurth, newly elected president New England State Association, N.A.S.E.; Daniel L. Smith, retiring president; Thomas Clark, newly elected vice-president; Theodore N. Kelsey; Patrick Hogan, Walter Daman, past National presidents N.A.S.E.; George Knowlton. Seated —H. E. Johnson, retiring conductor; F. S. Tyler, secretary, Mr. Eggleston, Thomas Ray.

Gas Engineer Needed by Government

The United States Civil Service Commission announces an open competitive non-assembled examination to fill a vacancy in the Bureau of Mines for duty at Fort Worth, Texas, for an associate gas engineer. The duties of the position include general supervision of the power plant, gas distribution and measuring system, etc. Entrance salary is $3,000. The receipt of applications will close Aug. 4.

Report on Wynooche Water Power Development

In a report upon the Wynooche power development proposed by the City of Aberdeen, Wash., Carl F. Uhden, former chief engineer on construction of the Skagit River hydro-electric power plant, states that 15,000 hp. can be developed at a cost of $2,639,000. The City of Aberdeen will submit a $2,639,000 bond issue to the voters soon.

Muscle Shoals Power Sold Cheap

Sale of power at Muscle Shoals for two mills a kilowatt-hour is being criticized in certain quarters as an inadequate return. In defense of the arrangement with the Southeastern power companies, officers at the Corps of Engineers point out that ample opportunity was given all those interested to offer a higher figure. No one else was found who was willing to pay anything for power under the conditions of delivery that must prevail during the testing period. Two mills was all the power companies would pay when there was to be no assurance as to the continuity of operations.

Both Colonel Spalding and Major Tyler, who have national reputations as hydro-electric engineers, made careful calculations and agreed that two mills is a reasonable rate. Even were it inadequate, that rate was the absolute limit that the power companies were willing to pay. It was a case of accepting that offer and returning some $500,000 to the Treasury, or receiving nothing for the power.

Annual Convention and Mechanical Exhibition, New England

Westinghouse Forms New Unit for Japan

A further extension of the Westinghouse activities in foreign fields was made known on July 15, in the announcement that a new company had been formed to be known as the Westinghouse Electric Co. of Japan. The company was incorporated under the laws of Delaware, with a capitalization of $1,000,000, and will provide facilities for distributing the company's products to the Japanese. It is to be a subsidiary of the Westinghouse Electric International Co. The officers of the new company are: Guy E. Tripp, chairman; L. A. Osbourne, president; E. D. Kilburn, vice-president; I. F. Baker, managing director. The staff in Japan will consist entirely of Japanese engineers.

Russia's Power Plans Call for $80,000,000 Expenditure

According to a news item published in the *New York Times*, July 16, an expenditure of 160,000,000 gold rubles, or upward of $80,000,000, for electrification in the Soviet Union is to be provided for in the Federal Soviet budget for the fiscal year 1925-26. This information was obtained from Kazimir P. Lovin, chairman of the Moscow Combination of State Electrical Stations, who is in New York accompanied by Boris A. Barsukov, manager of the technical department of the Moscow Combination; which is known for short as "Moges." They will study the electric power plants and the electrical industry of the United States. It was indicated that the Soviet industry might come into the market for American electrical apparatus for the developments under way and planned.

"Mr. Lovin said that while the electrical industries in the Soviet Union were still in their infancy, plans for electrification recently have been pushed at a rapid pace and the capacity of the stations are at present more than double the pre-war capacity, standing now at 512,000 kw. He said the plans now in execution provide for the construction of new stations and the re-equipment and enlargement of existing stations in 100 localities of Russia as the initial step.

"The plans include thirty stations for the system, having a capacity of 1,750,000 kw. Two of these stations, those of Balakhna in the Province of Nizhni Novgorod and Kizel in the Urals, have been completed. Nearing completion and partly in operation are the stations Volkhovstroy and Red October in the Province of Leningrad, Kashira and Shatura in the Province of Moscow, and the station Shterovka in the Donetz Basin. The total capacity of these seven stations is 194,000 kilowatts.

"Besides these, which are being constructed at the expense and under the control of the central organizations created by the Soviet Government for electrification, local initiative, according to Mr. Lovin, in many districts is building smaller electrical stations. Stock companies are helping with the participation of the authorities. He asserted it had already been possible to reduce the price of electric current to consumers to about a fourth of the pre-war rate.

"In Moscow, where the stations are combined under the management of 'Moges,' the capacity by the end of this year will be brought to 155,000 kilowatts, compared with 78,000 in December, 1924. The earnings in the fiscal year ended Sept. 30, 1924, amounted to 21,000,000 rubles, and expenses, including amortization and 3,200,000 rubles set aside for re-equipment of plants, were 20,000,000 rubles. This left a profit of 1,000,000 rubles.

"Lovin and Barsukov are electrical engineers, trained in Russia. They expect to stay here about three months and will visit the electrical plants of the General Electric Co. and the Westinghouse Electric & Manufacturing Co. They also plan to visit Muscle Shoals to study the government's power development.

"The Soviet power industry has been buying its equipment in Germany, Czechoslovakia and England heretofore, because of credit advantages."

That, contrary to widely prevailing impression, there are proportionately so few very large concerns, and that the majority of factories are small, not even medium-sized, is graphically shown in a chart just prepared by the National Industrial Conference Board, Inc., 247 Park Ave., New York, based on the 1920 census. On the other hand, the chart shows that only 3.7 per cent (7,333) of the 196,267 plants covered by the census, turned out more than half, or 59 per cent of the value of all manufactured goods, totaling $43,653,282,833 during the census year.

Post Office Recent Rulings on Catalogs

A catalog, according to the Post Office Department's interpretation of the new postal rates, is not a catalog when it contains less than twenty-four pages. And not being a catalog, it is not entitled to the rate of 1c. per 2 oz., but must bear a rate of 1½c. per 2 oz.

The effect of this ruling has been that many business houses are increasing their catalogs to 24 pages with a tendency to break down well-established trade standards of paper size, printing and folding.

Some have discovered that by attaching a circular, on which the rate is 1½c. if mailed alone, to a 24-page catalog, the whole can be mailed for 1c.

These and other effects of the new postal rates will be considered by the Joint Subcommittee of Congress at hearings started July 20.

Two Mexican Power Projects Announced

Plans for the development of Lower California, near San Quentin Bay, about 200 miles south of Ensenada, Mexico, are being announced, according to the press, by Abelardo Rodriguez, governor of the northern district of Baja California. The plans include the erection of a dam in the Santo Domingo River, creating a reservoir which will supply water for irrigation and will also provide for the development of considerable power. The total cost of the project will be approximately 3,000,000 pesos. The territorial government of Lower California is to finance the dam and irrigation system, and the federal government has agreed to furnish funds for the individual farmers to improve and equip their allotment of the 70,000 acres in the development. All this money is to be repaid under a system similar to that operated by the United States reclamation service.

A power project is being promoted by Governor Enrique R. Najera of the State of Durango, Mexico. He has interested a group of American investors in the construction of a dam across the Tunai River which will form a catchment basin for storing the flood waters that come from the rains and snows in the Sierra Madres. Engineering estimates are that more than 200,000 hp. may be generated by the proposed hydro plant.

States Association of the N.A.S.E., Worcester, Mass., July 9-11

Comal Power Co. Builds New Plant

The Comal Power Co., a subsidiary of the American Light & Traction Co., is building a new generating plant on the Comal River near New Braunfels, Tex. The plant will cost about $3,000,000 and will have an initial capacity of 30,000 and an ultimate capacity of 100,000 kw. It will serve San Antonio and vicinity and the Texan Power and Light Company.

Ontario Hydro Gets Authority to Develop Ottawa River

The provincial government of Ontario has authorized the Ontario Hydro-Electric Power Commission to proceed with the development of power at five sites on the Ottawa River in the neighborhood of the city of Ottawa. The sites to be developed are Rocher Fendus Rapids at the south side of Calumet Island, Chenaux Rapids, 52 miles west of Ottawa, Chat Falls, 32 miles west of Ottawa, Deschene Rapids at Ottawa embracing the head from the existing development at Chaudiere Falls to the foot of Chat Falls, and Carillon Rapids, including the fall at Point Fortune and at Hawkesbury. Estimates of the power available at these sites vary from 250,000 to 400,000 horsepower. The estimated cost of development is placed at $25,000,000.

Austria Increasing Hydro Plants

The present Republic of Austria is rich in water-power sites, and it is estimated that there might profitably be developed about 1,700,000 hp. Until the end of the war and the splitting up of the old empire, development was hampered by the opposition of the owners of the coal mines in Bohemia and by that of the Austrian War Department.

In the year 1921, and in 1922 there were completed 11 plants of 17,000 hp.; in 1923, 4 plants totaling 8,100 hp.; and in 1924, 13 plants with 60,500 hp., and 9 more plants, with 19,700 hp. were practically completed.

It is estimated that for full operation of its industries Austria will require electric power to the amount of 900,000 hp., of which 172,000 hp., or 19 per cent, was supplied by the plants in operation at the beginning of 1921; at the end of 1924, to the extent of 31 per cent by the addition of the plants then completed, or if the work done on plants still under construction is included, to the extent of 34 per cent. On the completion of the projects now under construction, more than 40 per cent of the demand will be supplied.

It is estimated that a yearly saving of 800,000 metric tons of coal, amounting to about $6,000,000, will result.

A law provides for furthering the construction of hydro-electric plants by remission or reduction of taxes.

It is the aim of the Austrian Water Power and Electric Commission, known as "Wewa" (Osterr. Wasserkraft-und Elektrizitaetswirtschaftsamt), to complete the development of 900,000 hp. within 15 years from the end of 1920.—*Commerce Reports.*

Water-Power Resources of Hawaii

The United States Geological Survey has recently prepared a survey of the potential water power of Hawaii based on a study of the flow and fall of the streams. The potential power is estimated at 174,000 hp. for 50 per cent of the time and 72,000 hp. for 90 per cent of the time, divided among five islands.

Most of the water power developed is generated by small scattered plants, practically all on sugar plantations. The rotor capacity of the waterwheels and turbines now in use is about 25,000 horsepower.

Well-Type Burner To Be Used on Steamships

The Fuller-Lehigh "well-type" burner, described in *Power*, June 9, page 927, is being tried out on a steamship belonging to a New York firm. It is estimated that a saving of $5,000 a voyage would be made by vessels using the new system, according to statements made by H. W. Brooks before the fuel committee of the Shipping Board, at a meeting on July 16. A special feature calls for the utilization of a coal crusher on board ship. This will pulverize bituminous coal, which is then conveyed to the furnace by an apparatus that will feed it under a blower system to four burners, two of which are on opposite sides of the furnace. Fuel passing through these burners, will form a spiral which will give complete ignition.

Water-Power Projects

Another Permit Asked for on Kentucky River—The Kentucky Hydro-Electric Co. has applied to the Federal Power Commission for a preliminary permit on the North Fork of the Kentucky River near Airdale, Ky., in direct conflict with the application filed by Offut, Longbridge, Gunn and Hitner, October 13, 1924.

Lewis River—Application for water-power rights on the Lewis River, Wash., has been filed with the State Department of Hydraulics at Olympia by H. L. Gilbert, of Portland, Ore., who asks appropriation of 2,000 sec.-ft. of water for the development of a hydro-electric power plant of 50,000 hp. The work is estimated to cost $3,000,000.

New River Project—The New River Development Co. has advised the Federal Power Commission of its intention of undertaking a development on New River near Hiwassee, Va. The development would affect the river from Hiwassee to a point near the mouth of Little River, twenty miles distant. It is proposed to install four units of 15,000 kw. each.

Ohio River Developments—Dam 41, in the Ohio River at Louisville probably will be raised eight feet. A decision in the matter is expected in the near future. If this is done it will eliminate the need for building proposed Dam 40 at Madison, Ind., fifty miles up stream from Louisville. The increased height will create a pool extending for 75 miles. The dam, however, will be flooded out at periods of highest water, an average of 45 days a year. The improvement will permit the generation of 350,000,000 kw.-hr. annually. The Louisville Hydro-Electric Co. holds a preliminary permit from the Federal Power Commission covering the development and has pending an application for license. The work on the dam will be done by the Corps of Engineers but the Hydro-Electric Co. will build the power house. Two working seasons will be required for the construction work.

Personal Mention

Sir Dugald Clerk has been honored recently by the University of Liverpool conferring of the honorary degree of doctor of engineering.

Dr. Albert E. White, professor and director of engineering research in the University of Michigan, has been honored by Brown University in the conferring on him of the degree of honorary doctor of science.

O. C. Merrill, Executive Secretary of the Federal Power Commission, sailed July 17 from New York for London to attend the meeting on July 27 of the international executive committee of the World Power Conference.

Obituary

Louis F. Massa, vice-president of the A. D. Granger Co., power-plant machinery, 15 Park Row, New York City, died on July 2 at the Englewood (N. J.) Hospital from typhoid fever. Mr. Massa, who was 56 years old, graduated from Columbia University in civil and electrical engineering with the class of 89-90. His early work after graduation was principally with steam turbine development and later in the electrical contracting line. He joined the A. D. Granger Co. in 1900.

John Coleman, of the marine department of Babcock & Wilcox Co., died on April 18, 1925, at Cleveland, Ohio. Mr. Coleman was born in England in 1866 but came to America when he was a small boy. Circumstances compelled him to work at an early age, thus depriving him of any opportunity for acquiring a technical education. He started at fourteen in the fireroom of steamers on the Great Lakes, gradually advancing until he was chief engineer with unlimited license. In 1895 Mr. Hoxie of B. & W. Co. became acquainted with him and through this connection Mr. Coleman entered the employ of the B. & W. Co. at the time it was establishing its marine department. After the conclusion of the World War, during which Mr. Coleman was very active as superintendent of marine erection, a new office was created, that of chief operating engineer, to which he was appointed. He was a member of the Society of Naval Architects, and Marine Engineers, Society of Naval Engineers, Marine Engineers' Beneficial Association, and a Mason. He is survived by a widow and four children.

Business Notes

The Trico Fuse Manufacturing Co., Milwaukee, Wis., announces the removal of its Chicago district office to Monadnock Block, West Jackson Blvd., Chicago, Ill.

Foote Bros. Gear & Machine Co., 215 Curtis St., Chicago, Ill., announces that the McBurney Stoker & Equipment Co., 619 Trust Co., Georgia Bldg., Atlanta, will represent it in the State of Georgia.

The Uehling Instrument Co., 473 Getty Ave., Paterson, N. J., has just appointed Charles M. Bullard, 912 Washington St., Appleton, Wis., as its representative for central and northwestern Wisconsin.

The Sullivan Machinery Co., 122 South Michigan Ave., Chicago, Ill., announces the appointment of Raymond B. Hosken as general sales manager of the domestic sales of the company, effective July 1.

The Dean Hill Pump Co., Anderson, Ind., announces the appointment of Wagner & Wagner, El Paso, Texas, as its representative in the El Paso territory, and J. Harry Burroughs, 502 Marine Trade Bldg., Buffalo, N. Y., as representative in the Buffalo district.

The Fulton Company, Knoxville, Tenn., originators and manufacturers of "Sylphon" specialties, has recently published a booklet in which are reprinted the important patent decisions in the courts upholding the "Sylphon Bellows" patents, owned by the company.

Trade Catalogs

Tachometer—James G. Biddle, 1211 Arch St., Philadelphia. Bulletin No. 1080 describes the Jagabi Type-B stationary tachometer for the continuous indication of speed, manufactured by this firm.

Stoker—Riley Stoker Corp., 9 Neponset St., Worcester, Mass. Catalog No. 90, "The Jones Side-Dump Stoker," is attractively arranged, giving pictures of installations, blueprints of designs and clear descriptions of this type of stoker.

Electric Dumb Waiter—The Warner Elevator Manufacturing Co., Cincinnati, Ohio. A bulletin, No. F-18-B, recently published by this company, describes the Type F-18 electric dumb waiter, capacity 200 lb., manufactured by them. Clear illustrations of the mechanism and its control are shown.

Valves, Fittings, Pipes — Walworth Manufacturing Co., Boston, Mass. A new catalog recently published in book form is of convenient size and shape for easy reference and contains a good index. It includes in its 715 pages, pictures, descriptions and tables of dimensions, etc., of the innumerable items manufactured by the company.

Steam Specialties—The Hoppes Manufacturing Co., Springfield, Ohio. Catalog No. 85, "The Larches," of convenient size, covers the feed-water heaters, V-notch meters, live steam feed-water purifiers, steam separators, oil eliminators and exhaust heads manufactured by the company. It is well illustrated and contains instructions for the installation of this equipment.

Coming Conventions

American Chemical Society. Charles L. Parsons, 1709 G St., N. W. Washington. Meeting at Los Angeles, Aug. 3-8.

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Universal Craftsmen Council of Engineers. Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Twenty-third international convention in the Armory, at Akron, Ohio, August 3-8.

Trap, Steam — Illinois Engineering Co., Leaflet "Illinois Steam Trap and its 10 Points," contains a large-sized section drawing of this trap.

Steam Turbines — Erste Bruenner Maschinen - Fabriks - Gesellschaft, of Bruenn, Czechoslovakia. The new catalog written in English explains many principles and details of this highly efficient type of turbine. In addition to a well-illustrated text a list of published technical articles bearing on this type of turbine is included. Copies may be obtained from R. Hertl, 9004 180th St., Jamaica, Long Island, N. Y.

Diesel Engines—Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago, Ill. "Modern Methods in Diesel Engine Building," has recently been issued by this company. It is an interesting 30-page pamphlet discussing the manufacturing methods followed at the Beloit Diesel engine factory. Many illustrations are shown in color, those showing the forging processes being especially good. A copy can be obtained by addressing the company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	July 13, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	4.20@ 4.35
Clearfield	Boston	1.65@ 1.95
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.40@ 1.65
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.35@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.60

FUEL OIL

New York—July 15, light oil, tank-car lots; 28&34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—July 14, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5.25c. per gal.

Pittsburgh — July 15, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—July 11, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia — July 10, 28@30 deg., $2.205@$2.268 per bbl.; 18@22 deg., $1.932@$1.985; 13@16 deg., $1.68@ $1.743 per bbl.

Boston—July 13, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal. light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — July 13, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

New Plant Construction

Ariz., Yuma — Bureau of Reclamation, P. W. Dent, Acting Comr., will receive bids until August 20th for the construction of a siphon drop power plant including two 1,160 hp. vertical hydraulic turbines, generators, transformers, switchboard, etc.

Ark., Searcy—City will soon receive bids for the construction of a pumping station including a 200,000 gal. filter basin, gravity filters, etc. Estimated cost $70,000. Dickinson & Watkins, 608 Boyle Bldg., Little Rock, are engineers.

Calif., Alhambra — Temple Estate Co., c/o Walker & Eisen, 756 South Spring St., Los Angeles, Archts., is having preliminary plans prepared for the construction of a 6 story office and lodge building including steam heating system at 3rd and Main Sts. Estimated cost $500,000.

Calif., Los Angeles—Tifal & O'Connor, archts. and contractors, 709 Grant Bldg., will build an 11 story apartment including steam heating, automatic refrigeration, etc., at 52nd and Normandie Sts. Estimated cost $1,200,000.

Calif., Oakland — Boulevard Hotel Co., c/o J. L. Stewart, 703 Market St., San Francisco, Archt., is having preliminary plans prepared for the construction of a 14 story hotel at San Pablo Ave. between Market and 28th Sts. Estimated cost $2,000,000.

Calif., San Francisco—Glacier Palace Corporation of California, C. E. Hopkins, Pres., 227 Pacific Bldg., plans the construction of an ice skating arena. Estimated cost $150,000. T. H. Eslick, Santa Monica, is architect.

Calif., Santa Barbara—A. L. Richmond, Arlington Hotel, plans the reconstruction of hotel recently destroyed by earthquake. Estimated cost $2,500,000.

Calif., Santa Monica—Shoreham Hotel Co., 124 Vicente Blvd., awarded contract for the construction of an 11 story hotel including steam heating system and incinerator and probably refrigeration systems at 319 Ocean Ave., to Trewhitt & Shields, 801 Edwards & Wildey Bldg., Los Angeles. Estimated cost $1,500,000.

Conn., Greenwich—St. Lukes Hospital, S. Baker, Pres., Amsterdam Ave. and 113th St., New York, plans the construction of a hospital on King St. here. Estimated cost $1,000,000. Architect not selected.

Conn., Hartford—Bd. of Charities and Correction, Room 2, City Hall, is receiving bids for the consrtuction of a refrigeration and ice manufacturing plant for Springside Home.

Fla., Tampa — Tribune Publishing Co., W. F. Stovall, Pres., is having plans prepared for the construction of a 10 story hotel at Jackson and Pierce Sts. Estimated cost $1,500,000. B. C. Bonfoey, 12 Petteway Bldg., is architect.

Ill., Chicago—Marshall & Fox, 431 Michigan Blvd., Archts. and Engrs., will receive bids about August 10th for the construction of a 10 story apartment with 3 passenger and 3 freight elevators at 7321 South Shore Dr., for E. C. Waller, Jr., Burnham Bldg. Estimated cost $1,600,000. Engineer purchases heating equipment.

Ill., Chicago—Oman & Lilevtha, 64 West Randolph St., Archts., are receiving bids for the construction of a 15 story hotel including 2 passenger elevators, 1 freight and 1 service elevator for Hotel Eastgate Building Corporation. Estimated cost $1,000,000. Separate bids on heating system.

Ill., Chicago—Riverside Plaza Corporation, London Guarantee and Accident Bldg., awarded contract for the construction of a 40 story office building to Starrett & Dilks, Burnham Bldg. Estimated cost $7,000,000. Three 250 hp. high pressure boilers, 10 passenger and 1 freight elevator, etc., will be installed.

Ill., Springfield—City, W. J. Spaulding, Comr., is having plans prepared for furnishing a new 8,000 or 10,000 hp. turbo generator unit to power plant, sixth unit. Estimated cost $150,000.

Ind., Gary—Bd. of Public Works, M. Maloney, Clk., will receive bids until July 27th for the construction of a sewage pumping station. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., are consulting engineers.

Ia., Sioux City—Illinois Central R.R., 136 East 11th St., Chicago, Ill., awarded contract for the construction of a 1 and 2 story terminal building including a pump house, etc., here, to Grant, Smith & Co., Pioneer Bldg., St. Paul, Minn. Estimated cost $700,000.

Mass., Boston—Carlin & Cherney, 115 Brighton St., plans the construction of a 10 story apartment. Estimated cost $1,000,000. Owner builds by separate contracts.

Mich., Jackson—W. R. Reynolds Co., 16 West Main St., will soon award contract for the construction of a 14 story office building including steam heating system with boiler, on Michigan Ave. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Miss., Belzoni—City, F. M. Pepper, Clk., will receive bids until August 1th for two sewerage pumps for unscreened sewerage, and two dry-pits for pumps. D. M. Forester, is city engineer.

Miss., Isola—City is having preliminary plans prepared for the construction of a waterworks system including pumping equipment, tank on tower, etc. Estimated cost $25,000. H. A. Mentz, Citizens National Bank Bldg., Hammond, La., is engineer

Mo., Cape Girardeau—Community Light & Power Co., H. C. Newman, Dist. Mgr., 408 Pine St., St. Louis, plans improvements to plant including the installation of a 2,500 kv. turbine here. Estimated cost $200,000.

Mo., Kansas City—W. C. Gumm, 504 West 75th St., is having plans prepared for the construction of a 14 story hotel, theater and office building at Troost St., Forest Ave. and Linwood Blvd. Estimated cost $2,500,000. H. A. Drake, 315 Reliance Bldg., is architect.

Mo., La Plata—City Clerk, W. R., will receive bids until July 22nd for the construction of a filter plant including 5 centrifugal pumps and motors, earth dam, tank on tower, etc. W. B. Rollins & Co., 521 Railway Exchange, Kansas City, are engineers.

Mo., St. Louis—Bd. of Public Service, will soon receive bids for the construction of a heating plant for Plaza group of public buildings, on Clark Ave. Estimated cost $910,000. L. R. Bowen, 301 City Hall. is architect and engineer.

Mo., Neosho—City plans an election soon to vote $30,000 bonds for extension to waterworks system, including installation of gas engine and electric motor. Black & Veatch, 700 Mutual Bldg., Kansas City, are engineers.

Neb., Phillips—H. Johnson, Village Clk., will receive bids until July 30th for the construction of a waterworks system including 1 single stroke deep well pump 40 g.p.m. at 35 crank r.p.m., 1 two stroke deep well pump 60 g.p.m., 30 crank, one 7½ hp. 3 hp., 220 v. 1,200 r.p.m. a.c. motor. Estimated cost $25,000. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. J., Plainfield—Common Council will receive bids until August 3rd for the construction of a sanitary sewer and sewage pumping station. A. W. Vars, City Hall, is engineer.

N. Y., Colonie—Sewer Comns. School District No. 22, A. Petregal, Chn., will receive bids until July 30th for the construction of a sanitary sewer system and disposal plant including pumping station, etc. Solomon & Keis and H. E. Gabriels, Troy, are engineers.

N. Y., Gouverneur—Bd. of Light Comrs., will receive bids until August 3rd for the construction of a 175 ft. dam and a 20 x 36 ft. power plant. L. C. Reynolds, 387 Castle St., Geneva, is engineer.

N. Y., New York—I. F. Roe, c/o Deutsch & Schneider, 35 Maiden Lane, Archts. and Engrs., is having plans prepared for the construction of a 16 story apartment at Central Park West. Estimated cost $1,500,000.

N. Y., New York—Thompson Contracting Co., c/o Deutsch & Schneider, 35 Maiden Lane, Archts. and Engrs., will build two 15 story apartments at 91st St. and Riverside Drive and 87th St. and Riverside Drive by day labor. Estimated cost $1,000,000 and $1,500,000 respectively.

N. Y., New York—Union Railway Co., 2396 3rd Ave., is having plans prepared for the construction of an apartment on Colonial Ave. Estimated cost $500,000. C. M. Hart, 247 Park Ave., is architect and engineer.

O., Cleveland—Ohio Farmers Co-Operative Milk Co., R. W. Strong, Secy., 3068 West 108th St., is having plans prepared for the construction of a boiler house including a 100 hp. boiler and new refrigeration system at 3068 West 106th St. Estimated cost $40,000. Wright & Hohl, 4614 Prospect Ave., are architects.

O., Columbus—City Hall Development Co., 8 East Broad St., is having plans prepared for the construction of a 13 story theatre and office building on East State St. Estimated cost $1,000,000. G. Drach, 1701 Union Trust Bldg., Cincinnati, is architect.

Okla., Davenport—City will soon receive bids for the construction of a waterworks system including a deep well pump motor, tank on tower, etc. Estimated cost $33,000. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Elk City—City voted $236,000 bonds for improvements to waterworks and sewage systems including a sewage disposal plant, pumping equipment, water mains, etc. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer.

Pa., Philadelphia—Kenin & Shapiro, Inc., 5850 Market St., will soon award contract for the construction of an 8 story apartment at 4th and Walnut Sts. Estimated cost $1,500,000. Stepler & Deysher, Jefferson Bldg., are architects.

Pa., Philadelphia—Charles Lennig & Co., 40 North Front St., will soon award contract for the construction of a boiler house at Richmond and Kennedy St. C. A. Blatchley, Drexel Bldg., is architect.

Pa., Philadelphia—Walnut Construction Co., 48th and Walnut Sts., will build a 4 story apartment at 48th and Locust Sts., by day labor. Estimated cost $800,000. Stetler & Deysher, Jefferson Bldg., are architects.

Pa., Pittsburgh—Homeopathic Hospital, Center Ave., awarded contract for the construction of a power plant at Center and Aiken Aves., to D. T. Riffle, 1006 Forbes St.

Tex., Ennis—City plans an election July 28th to vote $60,000 bonds for improvements to waterworks system including additional pumping equipment, mains, etc. H. McCanless is engineer.

Tex., Grand Prairie—City voted $20,000 bonds for improvements to waterworks system including additional pumping equipment, mains, etc. Koch & Fowler, 606 Central Bank Bldg., Dallas, are consulting engineers.

Tex., San Benito—Valley Electric Co. plans extension to power plant to increase capacity about 2,500 hp. Owner will purchase Diesel units, etc.

Tex., Victoria—Victoria Electric & Ice Co., plans the construction of an ice plant, cork insulated and mechanically refrigerated.

Wash., Keyport — Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for extension to power plant at Pacific Coast Torpedo Station to J. Galber, Mutual Life Bldg., Seattle.

Wis., Eau Claire—Eau Claire Coffee Co., 121 South River St., will soon award contract for the construction of a 3 story warehouse including refrigeration system. Estimated cost $75,000. E. J. Hancock, Lacock Bldg., is architect.

Wis., Stoughton—City, C. Gander, Power Supt., plans to purchase new water wheels, flumes, belting, etc., for water and power plant. Estimated cost $30,000. Engineer not selected.

Ont., Essex — Dept. of Public Works, S. E. O'Brien, Secy., Ottawa, will receive bids until July 24th for hot water boilers for Public Building here.

Ont., Napanee—Dept. of Public Works, S. E. O'Brien, Secy., Ottawa, will receive bids until July 22nd for hot water boilers for the Public Building, here.

Ont., Sandwich—Dept. of Public Works, S. E. O'Brien, Secy., Ottawa, will receive bids until July 24th for a hot water boiler for the Public Building, here.

Que., Montreal—A. Bercovitch, Medical Arts Bldg., plans the construction of a hospital. Estimated cost $500,000.